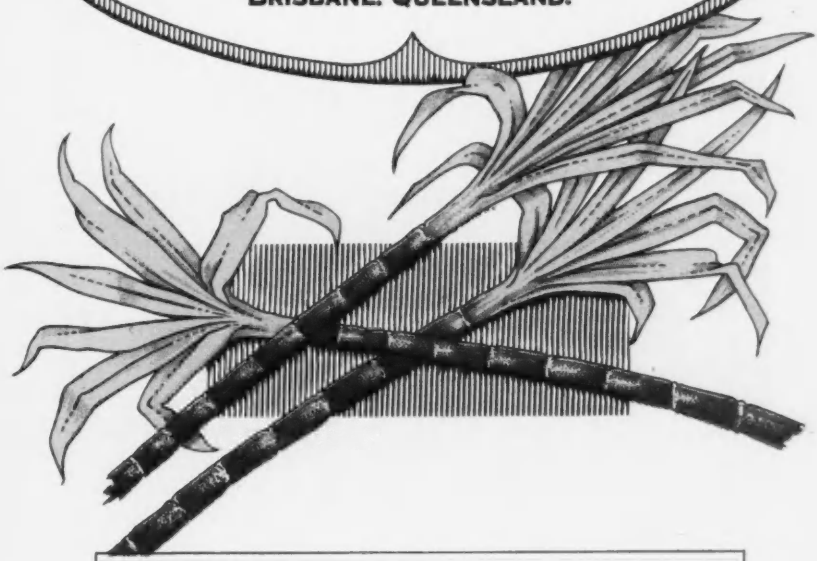
DEPARTMENT OF AGRICULTURE AND STOCK.

The CANE GROWERS' QUARTERLY BULLETIN

ISSUED BY
BUREAU OF SUGAR EXPERIMENT STATIONS
BRISBANE, QUEENSLAND.



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Registered at the G.P.O., Brisbane, for transmission by Post as a Periodical.

BUREAU OF SUGAR EXPERIMENT STATIONS
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QUARTERLY BULLETIN

ISSUED BY DIRECTION OF THE
HON. F. W. BULCOCK, MINISTER
FOR AGRICULTURE AND STOCK

1 APRIL, 1939

DAVID WHYTE, GOVERNMENT PRINTER, BRISBANE

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* Reprinted by courtesy of the Queensland Society of Sugar Cane Technologists.

The
Cane Growers' Quarterly
—Bulletin—

VOL. VI 1 APRIL, 1939 No. 4

Some Agricultural Problems of the Lower Burdekin District.*

By H. W. KERR.

IT is our privilege to meet again in what might justly be claimed to be the premier sugar-producing area of the State. The average production of cane and sugar per acre for the Pioneer, Kalamia, and Inkerman mills during the past five seasons has been:—

Season.	Cane per Acre.	Sugar per Acre.
	Tons.	Tons.
1934	32·3	5·04
1935	22·0	3·48
1936	30·4	4·74
1937	31·5	4·95
1938	28·2 (Est.)	4·37 (Est.)

Though it must be admitted that the district owes its pre-eminence, in a large measure, to the bounteous endowment of nature in providing both a rich soil and an abundance of readily available irrigation water, the possibilities which this combination promises could not be realised were it not for the ingenuity and skill of the farmers of the area in overcoming the inevitable local problems of crop production. In these three mill areas it is virtually impossible to produce crops without recourse to irrigation, and this phase of sugar agriculture has been admirably developed on the Delta lands.

It is my purpose, at this time, to enumerate and discuss briefly certain of the major agricultural problems of the district, and to indicate where possible the lines along which their solution may be found.

Soils of the Burdekin Delta.

The cane soils of the area are alluvial in character, and are generally richly supplied with all the essential plant food materials excepting nitrogen. In texture they vary from sandy loams to heavy clays, though the majority might be classed as loams. As is frequently the case in areas where the river course has so frequently changed, the deposition of sediments has been effected in a very haphazard manner: hence we find sandy loams with clayey or sandy subsoils; clay with sandy or clay loam

* Paper presented at the Ayr Conference, Q.S.S.C.T., 23rd March, 1939.

subsoils; and so on for all possible alternations of strata. This irregularity adds substantially to the problem of irrigation practice, in so far as it influences the rate of water absorption by the soil, and the freedom of sub-drainage in areas where the available water supply is somewhat rich in salt.

Although a mechanical analysis of a selection of these soils would show that they contain a predominance of silt and sand particles, and a relatively small proportion of clay, the last-named is generally in a highly dispersed and sticky state, and its properties bring with them special cultivation problems. Following irrigation, considerable difficulty is experienced in restoring the soil to a state of good tilth, and if cultivation be delayed unduly, the soil breaks up into intractable clods. The farmers of the area are at present devoting considerable attention towards the amelioration of this soil condition; one line of approach which has given very encouraging results is the application of moderate dressings of molasses, either to ratoon crops or to fallow land. In fact the apparently permanent benefits from the treatment are so widely appreciated that the demand for reasonably-priced molasses now exceeds the supply.

These experiences suggest that any practice designed to increase the organic matter content of the soil might effect similar results. Trash conservation is therefore urged, though the slow rate at which this material decomposes during the normal summer months, due to moisture deficiencies, is an objection. The rotting process could be accelerated by the aid of green manure crops. But the difficulty associated with the production of a heavy bean or pea crop, without recourse to irrigation, is a factor which prevents the more extensive exploitation of this excellent practice; but growers might discover that even this added effort and cost might well be repaid in the benefits obtained.

Though the Delta soils are normally not in need of liming to neutralise excessive acidity, the proximity of a fair quality earthy lime at a reasonable price has suggested the possibility of this material as an aid in soil improvement. The limited amount of available evidence indicates that this plan is worthy of more extensive trial. The benefits of liming in its influence on the physical condition of the soil have been recognised by farmers since early times; but whether any particular soil will be improved by such an application is best determined by actual trial. Dressings of gypsum might produce results, even where agricultural lime is not successful, but the cost of this material may be a drawback; but similar effects would follow the broadcasting of lime and flowers of sulphur at the one time. A field trial embodying lime, sulphur, and gypsum is at present being conducted by the Bureau on an area of land on the Home Hill side of the river. This block had been seriously affected in productivity by prolonged irrigation with water containing more than a safe limit of salt.

Quality of Irrigation Water.

A very extensive study of the irrigation waters of the area has been made by the Bureau during the past eight years. A review of the analyses was prepared recently by Cassidy [1]. He distinguished two major groups—(*a*) those containing little mineral matter, but with a definite amount of free alkali, and (*b*) more saline waters containing

no free alkali. The waters of group (*a*) bear a close resemblance in composition to the flood waters of the Burdekin River, while those of the second group resemble "diluted" sea water; in close proximity to the ocean or tidal water, the contamination by sea water often renders the water totally unsuited for irrigation purposes.

The limit of salt concentration which might be considered safe for the purpose cannot be stated with exactitude. Firstly, no extensive studies with harmful waters have been possible, as farmers naturally refrain from the use of waters which are excessively salt; and, secondly, the concentration of salt which would cause trouble varies with the soil type. With free soil subdrainage and rather liberal applications of the water, a salt content in excess of 100 grains per gallon may be quite safely handled; whereas on a heavy soil type salt accumulation may be serious with waters containing substantially less than this amount.

Fortunately, the canegrower is usually able to obtain access to a drift which yields good quality water, and perhaps the greatest value of the survey and "vigilance" tests conducted by the Bureau lies in the guidance they have provided to farmers seeking better water supplies.

Any soil treatment leading to an improvement in the physical conditions of the land would automatically lessen the dangers of salt accumulation, while the use of sulphate of ammonia in reasonable amounts as the source of nitrogen for the crop, will normally serve to neutralise the usual concentration of free alkali encountered. In certain extreme cases, however, more drastic corrective treatment may be necessary; moderate applications of sulphur could be expected to prove effective under these conditions.

Irrigation Methods.

The standard method of supplying water to date has been the furrow or semi-flood system. Where water is obtained at a reasonable cost, wastage of water has sometimes been accepted as a fair exchange for saving in costs of labour for water application. Furrow irrigation inevitably introduces the complication that the margin of the field at which the water enters must be excessively flooded, if the distant end of the furrows is to receive its adequate supply. Moreover, the poor grades which are the rule in the Burdekin Delta make it essential to "drive" a large volume of water through the field, and this tends to excessive flooding.

Not only might exception be taken to the wastage of water, but the influence of the mechanical action of running water on the soil structure, combined with the aggravated effects of impurities which it contains, are definitely deleterious to the maintenance of a favourable physical condition of the soil. Increasing the frequency of supply ditches, with the consequent shortening of water furrows should lead to an improvement in this regard: moreover any increase in labour costs would be offset at least in part by a saving in pumping costs, while water supplies would be conserved.

The Bureau has attempted to direct attention to the possibilities of spray irrigation, as offering scope for the elimination of many of the irrigation farmer's troubles, while effecting savings in water and cultivation costs. Recent trends favour the use of rather heavy gauge

portable fluming, combined with an efficient sprinkler operating on low or medium pressures. Doubtless our delegate to the Louisiana Conference (Mr. N. J. King) can provide interesting overseas information along these lines, while it is worthy of note that a few of our own canegrowers who have experimented with spray systems during the past year have expressed themselves as satisfied with the prospects they offer.

Soil Plantfood Requirements.

I have already stated that the major soil plantfood deficiency of the area is in respect of nitrogen: this is a direct consequence of the natural organic matter (humus) deficiency of the soils generally. The Bureau has conducted extensive trials to determine the most profitable applications of sulphate of ammonia for the Delta soils. Though top dressings applying 3 cwt. per acre are normally adequate for plant cane, evidence is available which suggests that on some of the older lands, this amount might be increased with advantage. For ratoons, the optimum application is usually over 4 cwt. per acre, with more liberal dressings for soils which have been cultivated intensively for many years. One of the several virtues attributable to an application of molasses is the nitrogen supply which it adds to the soil; and after a reasonable dressing (6—8 tons per acre), the amount of sulphate of ammonia necessary may not exceed 2 cwt per acre. The advice regarding green manuring is further supported by this natural nitrogen deficiency, and where a heavy leguminous crop has been turned under prior to planting the cane crop, the sulphate of ammonia top dressings could be reduced, if not withheld entirely.

Farmers of the area are advised always to employ a moderate drill application of a planting mixture in order to preserve the natural supply of phosphate and potash in the land, and to guard against any possible deficiency from this cause: the applications need not, in general, exceed 2—3 cwt. per acre.

Certain growers who have been able to effect substantial crop yield increases due to the employment of more suitable manures, are frquently faced with a disconcerting drop in the C.C.S. of the crop. This may be due in part to over-treatment with nitrogen, and reduced applications of sulphate of ammonia might be tried to advantage. Forced early growth, combined with a tapering off of water application as the autumn approaches, should also prove helpful, while the consistent use of planting mixtures with a reasonable potash content will tend to accelerate maturity.

Ratooning Problems.

It is not many years since the practice of ratooning was virtually dropped from the programme of farmers on the older lands of the district. It is pleasing to note that the combined studies of the farmers and the Bureau have led to the discovery of at least some of the reasons why ratoon crops previously failed. The problem involved in getting an early application of water to the stubble, so that an adequate dressing of sulphate of ammonia could be made available for use by the young crop, is one of the most important reasons for many past failures. Doubtless the system will always involve difficulties so long as hilling-up is practised, and farmers consider this essential with the present irrigation methods. Ridging in this manner gives trouble in getting water to the stubble, while it also tends to "bring the stools to the surface."

Obviously the level cultivation methods which could be restored with spray irrigation stresses a further point in favour of this system. The adoption of methods for permanently improving the physical conditions of the land could also be expected to provide more favourable conditions for better and continued ratoon cropping. Trash conservation, by rolling into alternate interspaces, might enable this material to be saved, and also lead to economy in water consumption by ratoons: we have employed this method successfully in the Bundaberg area.

Cane Varieties, Pests and Disease Control.

While it may rightly be claimed that the district would benefit from an infusion of new cane varieties, with special properties, it must be admitted that the present standard varieties are well suited to the district. Canes of the P.O.J. type, with growth and ratooning vigour, would be assets to the districts; but it has been found necessary to exclude the best of these due to their high susceptibility to downy mildew disease. In an attempt to eliminate this disease, variety B.208 was disapproved a few years ago. Had the growers of the area co-operated to a man in the removal of this variety from cultivation, and adhered rigidly to approved canes only, it would have been possible to re-introduce B.208 and probably certain P.O.J. varieties also during 1939. Unfortunately, diseased areas of B. 208 still exist in the district, while plantings of S.J. 16 (in ignorance, it is admitted) have also served to perpetuate the disease in the area. Those who appreciate the worth of B. 208 realise only too well what this means to them.

At the present time, a suitable early maturing cane is necessary to replace Clark's Seedling, which gives usually only a medium tonnage yield, and is often badly affected with sour rots. The Bureau-bred Q. 20 (a seedling of Badila) shows promise in this respect, and a plot of the variety was established in the district last year. At Mackay it has shown phenomenal C.C.S. values, and it possesses reasonably good ratooning qualities. Yield plots will be set out this year, and if it retains its promise, the cane will be distributed in 1940.

Small plots of other promising canes are also in the area, while the better seedlings raised in other centres will be brought to the Burdekin district for trial as soon as possible. This area is particularly fortunate in that it has escaped the major cane diseases of Queensland, and it is worth while holding up the introduction of new canes for a year or two, if in so doing we can then be certain that all risks of disease introduction are avoided.

The major pest of the district is the greyback grub, which assumes serious proportions from time to time in certain localities. There would appear little danger of this ever becoming a district-wide pest, as conditions generally do not favour its existence. But for those farmers who suffer losses every year from the pest, we feel that the recently adopted policy of subsidised fumigation provides the best means of keeping the pest in check, while saving the infested crop. Giant toads have been liberated also, but it will be some time before their true value in pest control can be gauged.

REFERENCE.

[1] Cassidy, N. G.: 1937. Irrigation Waters of the Burdekin Delta. Tech. Com., Bur. Sug. Expt. Stns. Qld., No. 1, pp. 1-16.

The Introduction of Sugar-cane Varieties from Overseas Countries.*

By Arthur F. Bell.

I FEEL that perhaps some apologies are due for further discussing a subject which was fully dealt with as recently as the October issue of the *Cane Growers Quarterly Bulletin*. However, there seem to be so many misconceptions regarding this phase of our activities that we have deemed it desirable once again to set out the position and open the matter for discussion by this Conference.

There are no varieties of sugar-cane native to Australia, and our sugar industry has been built up entirely on imported canes. From first to last something of the order of one thousand varieties have been imported into Australia, although this figure certainly includes many duplications. The bulk of these have comprised inferior "chewing-cane" varieties collected by various expeditions to New Guinea and which were soon discarded.

Since Australia had no native sugar-canes, it had, of course, no native diseases which are purely sugar-cane diseases. This is a fact which is well always to bear in mind, viz., that our imposing array of serious sugar-cane diseases has also been imported from abroad. These diseases were *all* introduced into the country per medium of cuttings taken from diseased plants, although doubtless these plants appeared disease-free to the untrained eye of the exporter; one cannot imagine that diseased cane was either deliberately or knowingly introduced in any one case.

The early importation of varieties was a happy-go-lucky affair; one wrote to a friend or relative somewhere abroad and a parcel of cane returned without let or hinderance by the next mail. Gradually, however, it became obvious to authorities that this was a very dangerous practice inasmuch as cane diseases were being spread by this means from country to country. The result was that in several countries the importation of foreign varieties was prohibited unless the imported varieties were subjected for a period to rigid quarantine conditions. Such countries, Hawaii for example, have their reward in a comparative freedom from major diseases which they have maintained to this day.

Unfortunately, Australia was very slow to move in this respect and we have the inevitable heritage in the greatest, and thus the worst collection of sugar-cane diseases ever assembled on this earth. Nevertheless, all is not entirely lost and the stable gate may yet be shut wtih advantage. The parasites which cause plant diseases frequently exist in several strains, and these strains do not attack all varieties of the one plant alike. Therefore, although we may have a particular disease present in this country it does not follow that we have all possible strains of that disease.

Most of you will have some recollection of the parlous conditions to which mosaic disease reduced the sugar industry in Louisiana some twelve to fifteen years ago when production dropped from 250,000 tons of sugar to 50,000 tons. Now in Louisiana there are at least six different

* Address given to Conferences of Sugar Organisations, Brisbane, March, 1939.

strains of mosaic; a variety which is immune to one strain may be very susceptible to another, or it may even be resistant to five strains, but very susceptible to the sixth, and so the problem of getting varieties resistant to the whole six strains is made very difficult.

We do not have these six strains of mosaic disease in Queensland, and hence it follows that it would be very unwise to import any cane varieties from Louisiana and plant them direct into the field, without first growing them in quarantine to ensure that they are free from any foreign strains of this disease.

In short, although we have mosaic disease in this country we have not all the available brands. And so it goes for other diseases. I hope, therefore, that I may have convinced you of the necessity for continuing to maintain strict control over variety importation and the absolute necessity for adequate quarantine facilities for the treatment of foreign varieties when they are imported.

Quite a number of canegrowers appear to harbour the belief that the present administration of the Bureau is inimical to the importation of varieties. It is now some ten years since the Bureau was reorganised, and therefore it is of interest to compare the importations made during this period with those made during the previous decade; when this is done we find that during the period 1928-1938 one hundred and five varieties were introduced directly into Queensland from overseas, as compared with forty-five for the 1918-1928 decade. In addition, during 1928-1938 some dozens of seedlings, raised by the C.S.R. Company in New South Wales, have been brought across the border, as well as a considerable number of foreign varieties introduced by that company and which were not duplicated by our own overseas importations. Furthermore in 1929, we had placed at our disposal a duplicate set of over one hundred varieties collected by an American Sugar Cane Expedition which visited New Guinea by aeroplane in 1928-9.

It will have become obvious that 1928-1938, so far from witnessing a slowing down in variety importation, has actually been a period of increased activity. It is true, of course, that these later importations have been done more unobtrusively. In days gone by varieties were brought into the country, rapidly propagated in a convenient cane district, and then distributed far and wide without further ado; nowadays, after passing through the required period of growth in quarantine, they are put in disease-resistance trials and the majority fall at this hurdle (as, indeed, we might expect they would since they were not bred and selected for resistance to our diseases). Of these varieties, of course, you hear nothing; but you are also saved the expense of finding they are disease susceptible *after* you have planted a big acreage.

The choice of the actual varieties which are to be imported from any one country presents a difficult problem. In making the selection one must, of course, be guided by the parentage of the variety and its possible or known resistance to any diseases present in Australia; we must also consider fibre content, sugar content, time of maturity, habit of growth, and its performance under conditions which might be similar to those obtaining in one part or other of the Queensland cane belt. In making any such selection a personal visit to the country in question is of very great assistance, of course, and periodic visits by Bureau

officers should perhaps be considered a necessity from this standpoint. Furthermore, in the absence of personal visits we must rely upon published reports and these, of course, are always delayed.

In recent months, several Queensland technologists have visited Hawaii and two agricultural men have suggested a few seedling canes which they consider it desirable to import into Queensland. Actually the leading one of these varieties was imported into Queensland some twelve months ago and will go to disease trials next Spring; the others have been requested from the H.S.P.A. Incidentally, some extravagant claims seem to have been made for some of these varieties by persons who have not seen them. We have heard from several quarters that there are available in Hawaii some six or eight varieties which are greatly outyielding P.O.J. 2878, and it is at times inferred that the development of the sugar industry in Southern Queensland is being retarded by the fact that these canes have not been introduced here—as a result presumably of indifference on the part of the Bureau. Such ideas are not only wrong, they are silly. All that can be claimed for such varieties at present is that their performance in Hawaii justifies their importation and trial here. How they would perform under the different conditions prevailing in Queensland, and particularly in the presence of a different disease complex, is an entirely unknown quantity. On the irrigated plantations of Hawaii H. 109 is a long way ahead of P.O.J. 2878, but we know from past experience that that proves *just exactly nothing* regarding its performance in Southern Queensland, where it was rejected many years ago. In fact this variety has never been worth a second look anywhere in Queensland. S.J. 4 is a much better cane than P.O.J. 2878 in the North, but we all know that S.J. 4 was a dismal failure in the South. And so we might go on *ad infinitum*. It is rarely that a successful imported cane was of much consequence in the country of its origin.

No one in Mauritius appears to have heard of 1900 Seedling, and D. 1135 and B. 208 were never grown to an appreciable extent in Demerara and the West Indies. Badila, our Queensland wonder cane, is pretty well useless anywhere else; P.O.J. 2725; the standard cane of Formosa, was never grown commercially in Java. Indeed the only seedling which I can call to mind as being prominent in its own country and abroad is P.O.J. 2878, and it is of interest to observe that P.O.J. 2878 remained the leading variety of Java for only about five years.

And after all is not this failure to duplicate yields exactly what we should expect? A leading variety in any one country is a leading variety simply because it dovetails into the conditions peculiar to that country. If it is taken elsewhere the balance is upset and mediocre yields result.

In regard to the future, it would appear inevitable that we must rely much more upon locally-raised seedlings than has been the case in the past. Two factors make it likely that the importation of suitable varieties from overseas will be much more difficult than it has been. In the first place, the long period of economic depression has brought about the suspension of activities of a number of cane-breeding stations and the restriction of activity in others. In the second place, the modern surge of "Economic Nationalism" has not passed the sugar world by and we find an increasing number of countries either prohibiting variety exportation entirely or else greatly restricting it. If country

"A" finds its export market to country "B" greatly restricted by increased production in "B" brought about by the growth of a seedling bred in "A," it is natural that the contributors to experiment station funds in country "A" should not be keen in further exportation of varieties. Moreover, certain countries have never gone to the expense of establishing extensive cane-breeding facilities, but have relied upon the productions of their neighbours. And, naturally, this has not tended to develop the best possible international feeling.

Therefore, while we will endeavour to obtain as wide a selection of varieties as possible, on a reciprocal basis, it cannot be expected that the range will be as extensive as heretofore.

The Elimination of Gumming Susceptible Cane Varieties in the Bundaberg District.

In the lists of varieties approved for planting in Queensland during 1939 it will have been noted that a number of old varieties, notably D. 1135 and 1900 Seedling, have been omitted from the lists of all Bundaberg mills. It is thought that the farmers concerned would welcome an explanation of the reasons for this step.

As is well known, the diseases downy mildew and Fiji, but particularly downy mildew, are causing a great deal of concern in the Bundaberg district. The two leading canes, P.O.J. 2878 and P.O.J. 213, are both highly susceptible to downy mildew, while P.O.J. 2878, 2725 (and all other high-numbered P.O.J. canes) are highly susceptible to Fiji disease.

The situation, then, boils down to this. It is possible that the spread of downy mildew and Fiji disease may force us to discontinue the cultivation of the present standards, and we will then be faced with the very serious problem of what varieties to substitute.

At the present time, of course, we cannot consider the release of any varieties which are at all susceptible to gumming disease, as their survival would be very short-lived. If, however, we can eliminate from culture *all* stools of the old gumming-susceptible varieties we could then start off with a clean sheet and the standard of resistance required in respect of gumming disease could then be greatly reduced and varieties which would otherwise be discarded could then be retained.

The policy then is to make a serious effort to clear out gumming disease from the southern areas, and at present the only susceptible variety left on the Bundaberg lists is Mahona for restricted plantings in frosty areas.

If, then, we later have to beat a retreat in the face of downy mildew and Fiji diseases, it will be of great assistance if we can be assured that gumming disease has been eradicated from the district, and we need not further seriously consider this factor when choosing alternative varieties.

It is, of course, greatly to be hoped that it will not be necessary to abandon the P.O.J. canes. It would not be necessary if all farmers took reasonable care both in the selection of their plants and in the inspection of their crops.

A.F.B.

Sugar Cane in Hawaii and the United States.

By Norman King.

[*Editorial Note.*—Mr. King recently visited Hawaii and the United States on behalf of the Queensland Society of Sugar Cane Technologists as a delegate to the Sixth Conference of the International Society of Sugar Cane Technologists, held in Louisiana, U.S.A., last November. Mr. King's report, submitted to the Queensland Society contains much of direct interest to Queensland cane growers, particularly in regard to modern harvesting developments in Hawaii.]

HAWAIIAN PLANTATIONS.

The following plantations were visited during the stop-over in the Territory of Hawaii, en route to the Sixth Conference of the International Society of Sugar Cane Technologists, which the writer attended on behalf of this Society.

Oahu—

Ewa—Mr. Miller, Manager.

Waialua—Mr. Shaw and Mr. Swezey (Irrigation and Soils).

Hawaii—

Onomea—Mr. Anderson, Manager.

Pepeekeo—Mr. Spalding, Manager; Mr. Lyman, Agriculturist.

Paauhau—Mr. Carter, Manager; Mr. Black, Agriculturist.

Honokaa—Mr. Naquin, Manager.

Kohala—Mr. Pratt, Manager; Mr. Hind, Assistant Manager; Mr. Bond, Agriculturist.

Pahala—Mr. Cushnie, Manager; Mr. Hossack, Agriculturist.

Fig. 24.—Cane lands on the windward side of the island of Oahu, Territory of Hawaii.

At the various plantations a variety of subjects was enquired into and these are dealt with separately under their several headings. The most important matters were—(1) Cultivation, (2) irrigation methods, (3) varieties, (4) field experimental methods, (5) fertilizer practice, (6) grab harvesting and loading, (7) cane fluming.

Cultivation.

Cane land cultivation on the Hawaiian plantations embraces little that would be of direct value to Queensland, except perhaps to one or two of the large plantations. Progress has been along the lines of labour-saving devices, made imperative by shortage of man-power. Large implements and multiple units have been devised, not so much to save time or reduce costs as to get the job done by mechanical means in the absence of units of labour.

Fig. 25.—Double-line tractor-drawn planter at Oahu Sugar Coy. Note arrangement for fertilizer distribution and rollers for consolidating soil around plant.

Broadly speaking, the cultivation practice is as follows:—Final ratoon stubble is destroyed with large multiple disc harrow units. These are normally built of 30-in. or 32-in. discs from which have been cut away sectors so that a more efficient cutting action is transmitted. The outfit consists generally of two units, in tandem, and the whole is drawn by a 75-h.p. diesel caterpillar. The weight of the complete unit (4 tons) is sufficient in itself to penetrate the required depth for uprooting and chopping up the stools. On many plantations the multiple-disc ploughs are still used—eight- and ten-disc units—but there appears to be as much "ploughing out" done with the large tandem discs as with the ploughs. Killifer subsoilers are standard equipment on some plantations, but their use is restricted on the more rocky soils. Ploughs and disc harrows appear to be the only implements used in land preparation prior to planting. Rotary hoes are conspicuous by their total absence.

Surprisingly, in view of the reputed state of mechanisation of Hawaiian sugar-cane agriculture and the previously mentioned shortage of labour, the majority of the cane in Hawaii is hand-planted. Drills

are opened up by tractor-drawn drill ploughs. A cart drawn by mules or tractor follows the drill plough and two men on the cart throw the cane setts into two drills. The cane setts usually are placed end to end or overlapping in the drill. Further labourers follow, covering the cane setts with hoes.

On the few plantations which are using planting machines, few of the machines seen by the writer were doing a satisfactory job. The planter is in some cases built on a large caterpillar tractor, in others it is drawn by the tractor. They are two-row planters, opening drills in the same operation. (*See* Fig. 25.) In one case observed only 70 per cent. of the setts were covered by soil after the planter had passed, the others remaining on the surface in the furrow, and many gaps were left owing to irregular dropping of plants by the operators. Consequently the labour operating with the planter consisted of a tractor-driver, two men dropping plants, two men throwing plants in the furrow where gaps were apparent, and four men following with hoes covering such plants as were not sufficiently covered by the planter. The fertilizer distributors attached to such planters also appeared to be inefficient, delivering an irregular flow of fertilizer; some sections of the drill received none and others double the required amount. The vibrator type of distributor is apparently not used in Hawaii. Certain plantations are, in the case of hand-planting, covering the setts with a two-disc cultivator, which merely throws the soil from the furrow walls on to the sett.

Subsequent cultivation varies tremendously throughout the islands and is dependent on whether the plantation is irrigated or non-irrigated, and on the method of irrigation employed. Under non-irrigated conditions the rainfall is normally high and soil moisture is usually good at time of planting. In such cases supplies are planted as soon as the strike is well defined, the object being to have a continuous line of shoots with no gaps. Subsequent cultivation is along lines similar to those followed in Queensland except that a minimum of hand work is performed, all possible operations being done by mechanical means. Spinners are used very extensively for weed control, both in the cane row and in the interspace. The spinners are frequently mounted as multiple units, three spinners being operated from a common drive shaft behind a tractor. (*See* Fig. 26.) In such cases the spinners have no land wheels, being supported by the tractor. Single spinner units are mule-drawn. The multiple spinners are also used on irrigated plantations to throw any rubbish from the interspace furrows so that the water flow will not be impeded. All Hawaiian units are equipped with steel brushes instead of spoons on the periphery of the spinner.

Ordinary tyne cultivators or scarifiers are used for interspace cultivation in some places, but where they are used it is generally as multiple units drawn by a tractor. An 8-ft. tread high clearance Farmall-type tractor will draw from a rear bar four scarifiers which can be automatically lifted at will by the tractor-driver. Another method of interspace cultivation is by spring-tooth cultivators, doing two interspaces at a time and using a high clearance 22-h.p. tractor. Fertilizer distributors are sometimes built on the same tractor and the fertilizer dropped in front of the spring-tooth tynes.

These methods of interspace cultivation are employed on some plantations and to a certain extent solve the problem of labour shortage. Poisoning as a means of weed control, however, has made rapid advance

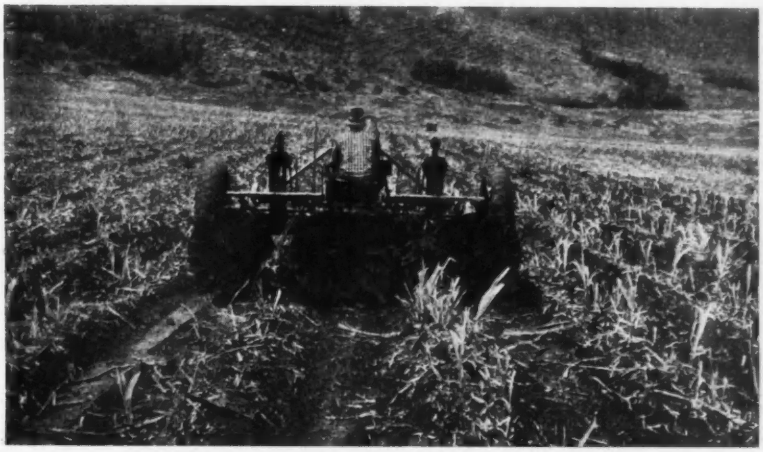

Fig. 26.—Triple unit spinner weeder, mounted on tractor.

in recent years, and to-day a big majority of Hawaiian plantations do practically no cultivation, but have evolved many types of weed-poisoning equipment. (*See* Fig. 27.) These cover all types, from knapsack sprays to high-powered pressure systems mounted on tractors and spraying several interspaces simultaneously. Arsenic-soda sprays are employed. The sprays are used right from the time of planting the cane. As the young cane develops, burning of the leaves is likely, and a certain amount of damage appears to take place from this cause. As the cane gets bigger, however, and no green leaves are near the ground, the damage is not so apparent. Some of the agriculturists are perturbed at the extensive use of arsenic for weed control, and are fearful of ill-effects due to accumulation of the arsenic in the soil. They

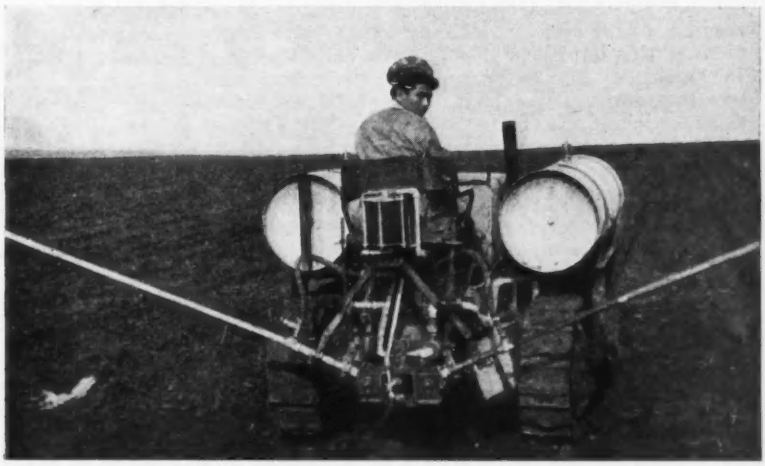

Fig. 27.—Broadcast spray machine used for weed destruction at Kilauea Plantation.

also point to the added expense to the employer through the large increase in hospital eye cases.

The sum consequence of this arsenic spray method of weed control has been to eliminate surface cultivation of soils entirely, and on such plantations the soil is not disturbed in any way from planting to ploughing out—some ten years later. This, on the basis of usual agricultural theory and practice, is not conducive to best results, but doubtless not all criticism advanced on this basis is justified. Only one plantation visited, namely, Olaa, where the plantation manager is a conservative agriculturist, carries out what Queenslanders regard as a normal cultivation routine for weed control and conservation of soil tilth. This plantation is in a good financial position and appears to be producing cane more cheaply than most of the others. He claims that cultivation allows him to use much less fertilizer.

After the plant crop is harvested, the tops are raked and burnt, but no implement is used for ratooning. Grubbing, ploughing away, and such ratooning methods are unknown in Hawaii. The stubble is merely allowed to shoot away again, and the same poisoning method of weed control, or, in a few cases, surface cultivation with implements, goes on as for the plant crop. The usual number of ratoons grown is four, so that with two-year cropping, the cane is in the ground for an average period of 10 years. The period between ploughing out and replanting is as short as possible. Frequently, cane is planted two weeks after ploughing out after the last ratoon crop. No green manure crops are grown.

On irrigated plantations the cultivation system may be divided into two sections—(*a*) Furrow irrigation and (*b*) Border irrigation.

(*a*) *Furrow Irrigation.*—Under this system the cane planting is similar to that for dry farming except that as soon as the strike is established an implement known as a "furrow shaper" is used to shape and widen the planting farrow. (*See* Figs. 28 and 29.) This consists of two discs opposed at an angle of about 90 deg., which operate on the two sides of the furrow, throwing soil upwards into the interspace. The result is a wide bottomed drill with easy flow for water. A later improvement of this implement has been the substitution of halved truck tyres for the discs. The tyres are cut in two around the periphery in such a way that a saw tooth edge is obtained. These replace the discs and make a better job of the furrow shaping. The Churchill shaper carries four discs, doing two furrows at a time, and is drawn by a 22-h.p. caterpillar. This implement is used both in plant cane and in ratoons to shape the furrow for irrigation water.

(*b*) *Border Irrigation.*—Very few plantations use this method of irrigation, very regular land being a prime requirement. In this method four-row and two-row borders are used and a dividing bank exists between each two borders. After planting, a disc cultivator—similar to a Cotton King with large discs—runs down the interspace and forms a ridge. This is done in every second or every fourth interspace, depending on whether 2- or 4-line borders are to be used. Thereafter the irrigation water flows into the section, fills the furrows, and floods the interspace until the ridge prevents further lateral spread. As the cane develops, the drills are filled in so as to make the border perfectly flat. After cutting the plant crop no cultivation is practised at all except to repair any breaks in the ridges caused by cane-harvesting implements.

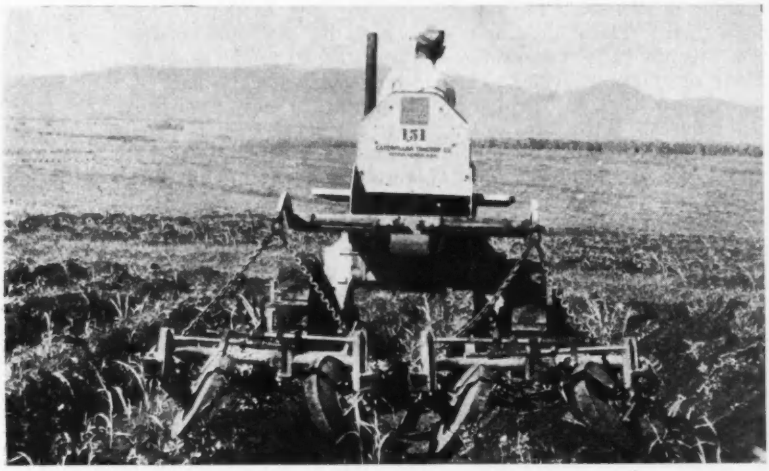

Fig. 28.—Churchill line reshaper mounted on 22 h.p. high clearance tractor. This implement is used to shape and widen drills prior to irrigation of plant cane.

The only two cultivation practices observed which would be of interest to Queensland growers were the furrow shaper for irrigation in the cane row and the multiple scarifying unit mentioned above. (*See* Figs. 26, 28, and 29.) The latter is already in use in Queensland, and appears to be a very satisfactory method. The 8-ft. tread high clearance

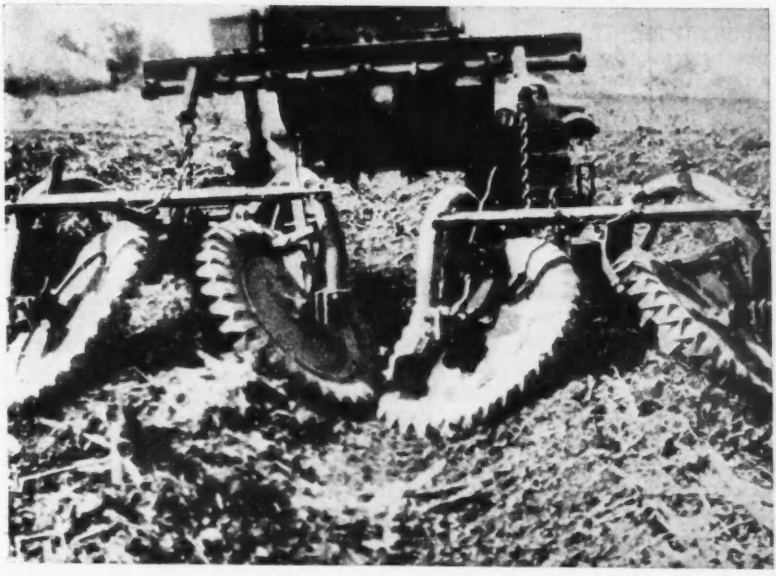

Fig. 29.—A modification of the implement illustrated in Fig. 28. This is also used as a revolving type weeder made by splitting old discarded truck tyres.

tractor is necessary for satisfactory working, so that two rows may be straddled. There does not appear to be any reason why rakes for weeding the cane rows should not be attached to the same multiple unit. Four scarifiers attached to the tractor cultivate one half of four interspaces, so that two runs are required to cover entirely the four interspaces. With, say, 160 chains to the acre (2 miles), the tractor has to cover only 1 mile to completely scarify 1 acre. Thus with a tractor speed of 3 to 4 miles per hour it is quite possible to cultivate 3 acres per hour.

Fertilizer for ratoons is generally spread by hand, but on some plantations a double-row spring tooth cultivator is fitted with a pair of fertilizer distributing boxes, which drop the fertilizer beside the cane row and just in front of the spring teeth.

A discussion of cultivation practices in Hawaii would not be complete without reference to Honokaa Plantation, where an unusual system of agriculture is followed. This plantation is situated on the island of Hawaii, on the northern edge of the very wet belt. Honokaa Plantation has no ploughs; fields are never ploughed out. A change of variety take place by supplying the old ratoons with the new variety until such time—usually 10 years—as the new variety has replaced the old. Fields of D. 1135 were seen which were originally planted in 1917 and are said to be still producing heavily. No doubt none of the original stools have survived, since ratoons are supplied at every harvest.

The original reason for this non-cultivation procedure was (1) the extremely stony nature of the entire plantation, and (2) the parlous financial position of the plantation some 20 years ago. It sounds like suicidal agriculture, but everyone must praise the manner in which the plantation has paid off a debt of a million dollars since 1923. The rainfall at Honokaa is extremely variable and the writer was told that while the rainfall in 1921 was 19 in., in 1922 it was 175 in. The miss-planting at Honokaa was rather interesting: In a plant crop (plant crops are sometimes found when a new variety plot is laid down) the setts—all top plants—are planted as in Queensland, but the leaf sheath is left on. When ratoons are used for plants the top 2 ft. to 2 ft. 6 in. of the stick is cut with the top on. It is cut back to above the growing point, planted in an upright position with two or three buds covered. Rooting takes places and the lower buds shoot, forming a stool. If the original top still lives, as it usually does, it is cut off and planted again, and so on.

Top plants are invariably used with standard varieties, the top being taken just prior to harvesting that block. In new canes, plants are cut at up to 12 months of age, and all of the stick is used. Top plants are preferred as being the youngest, and as the leaf sheath

Irrigation in Hawaii.

The writer must confess to some feeling of disappointment in the standard of irrigation as he saw it practised in Hawaii and feels that efficiency in this important phase of agriculture has not reached that standard which is generally attributed to Hawaii by people in this country.

Irrigation water in Hawaii can be very cheap or very expensive, depending upon its source. Certain plantations draw water both from wells and from mountain streams, but even this mountain water can be very expensive. A few details taken at random will explain this.

The great Waiahole aqueduct brings water to the Oahu Sugar Company from the opposite side of the Koolau Mountains, where ditches and tunnels tap the streams on the rainy side of the island. It was necessary to pierce the mountain range with a tunnel 2¾ miles long. This project took three years to complete and cost 2½ million dollars. Waialua plantation has built many ditches into the mountains at the rear of its estate and has dammed up a whole valley to form a reservoir of 156 million gallons capacity.

Fig. 30.—Stone and concrete main ditch at Waialua Plantation. On heavy grades all ditches are built of stone or concrete to prevent erosion.

On Hawaii there are three ditches penetrating the Kohala Mountains. These supply Paauhau, Honokaa, and Pacific Sugar Company with 15 million gallons daily. The Kohala ditch, 25 miles long, brings water to Halawa, Kohala, Union Mill Company, and Hawi Mill and Plantation. These tremendous and expensive undertakings make water expensive to deliver on the headlands, apart from reticulation and distribution costs on the plantation.

Underground supplies supplement these surface water supplies on many plantations, and the pumping plants on the various plantations represent an investment of nearly 10 million dollars in machinery alone.

Ewa plantation is dependent entirely on underground water and has a pumping capacity of 121 million U.S. gallons per 24 hours. The Pioneer Sugar Company, on Maui, pumps 300 million U.S. gallons per day.

Electricity generated by water power is being used on certain plantations. This is generated in gulches many miles from the plantations and is then conveyed to the plantations and used to drive pumps.

The man-day performance mentioned below suggests that the highest standard of labour and efficiency has not yet been reached on Hawaiian plantations.

There is no large variety of irrigation methods. The established practice is to irrigate every furrow individually (except in the border system) from one side of the watercourse. That this method is best is the opinion of the managers on the largest plantations. They make exceptions when conditions are not ideal.

Cutting lines: By this term is meant allowing the water to proceed to the end of the row and overflow to the next, through an opening, coming back toward the watercourse, until this second one is filled, and thus zigzagging back and forth down the field. Roughly two-thirds of the plantations make a practice of cutting lines. In plant cane single row irrigation is carried out for the first two or three months, after which line cutting is permitted. It is freely stated, however, that where water is short, individual line irrigation is the most economical. One investigation of the "labour saving" advantage of the "cutting line" method showed that on individual row irrigation a man could irrigate 1·385 acres per day and on the "cut-line" method 1·375 acres per day.

The alternate row method of irrigating cane is not now used. It was only an emergency measure in hilled-up cane when water was very short in times of drought. It results in a saving of water, but one experiment showed that with a saving of one-third of the water a ten per cent. loss of sugar resulted.

The so-called *automatic* irrigation system is more or less the Queensland plantation system. The supply ditch is dammed, thus backing up the water above the dam. Pipes are placed through the wide bank of the ditch leading into the cane furrow and according to the supply of water available, so many rows are irrigated simultaneously. Care is taken to have all pipes on the same level in the ditch. The only detail which is not used in Queensland is that the ditch gate is a slatted one with adjustable level. Surplus water, above that required in the ditch, overflows the gate into a second ditch of lower level. As this fills up it finds another series of pipes leading into the next section of the field.

There is nothing unusual or revolutionary about any of the irrigation in Hawaii, and the writer considers that irrigation efficiency, in terms of sugar produced per million gallons of water, is lower than on a well-irrigated plantation in Queensland.

Man-day performance is a figure on which it is very difficult to obtain reliable information and in the absence of precise figures there is perhaps a tendency to exaggerate the area irrigated per man-day. A specimen water distribution report for nine sections of one plantation was seen by the writer and furnished the following interesting figures:—

Section No.	1	2	3	4	5	6	7	8	9
Average application, acre inches ..	4·76	5·80	7·25	5·92	6·64	7·80	8·56	6·37	6·91
Average per man Acres per day..	3·92	3·19	3·10	2·98	3·24	2·35	3·49	2·78	3·02

A further table showed three years' work on the same plantation. Included therein are the following figures:—

	1934	1935	1936
Acre inches per acre per round	8.06	7.42	6.90
Acres irrigated per million gallons of water ..	4.57	4.96	5.33
Acres irrigated per man-day	1.71	2.16	2.86
Tons cane per acre	75.51	81.82	86.37
Tons sugar per acre	10.87	11.12	11.29

The improvement which can be brought about in economy and efficiency by careful control is illustrated by these figures. Where the writer was able to obtain information backed by figures, it generally followed along the above lines. Four acres per man-day must be regarded as a good performance in Hawaii. The Ewa border system can show slightly higher figures, but their method is very wasteful of water and would never be applied in Queensland, where water supplies are more often than not insufficient with the present furrow methods.

Spray Irrigation at Waialua Plantation.

This spray irrigation layout employs dual nozzle sprays, the two nozzles being diametrically opposed. The spray is driven by a patented action consisting of an oscillator arm actuated outward by the stream, and brought back through the stream by the medium of a torsional spring, causing an impact, and thus propelling the rotating member forward. The sprays are a slowly rotating type, making one revolution in five minutes. Six sprays per acre are used spaced 100 ft. x 100 ft. The throw of the spray is 80 ft. radius so that good overlapping is obtained. The nozzle pressure is 60 lb. and sprays apply from 3·13 in. in nine hours.

Sufficient material is available for 10 acres. The scheme is that 5 acres operate from 2 p.m. to 11 p.m., at which time the operator changes the valve over to the other 5 acres, which run till 8 a.m. From 8 a.m. to 2 p.m. labourers shift the line on to the next 10 acres. In this way 100 acres are covered in 10 days. Water is diverted from the main concrete flume from the hill reservoir into a still pond with three fine screens to eliminate rubbish. Water thus gravitates to an 8 in. electrically driven pump which supplies water at the required pressure to the spray line. The permanent underground pipe is of 4 in. wrought iron with aboveground attaching points of 4 in. wrought iron pipe. The spray line material is 16 g. galv. iron seamless drawn fluming, with end flanges welded on. The method of juncture is good, depending on the pressure given by a single lever lock, and also by the further sealing of a rubber ring caused by the water pressure. (*See* Figs. 33 and 34.)

The ring joint allows free radial movement through 10 degrees. Sulphate of ammonia is applied through the sprays by watering first, then an hour of water plus sulphate of ammonia, then more water to wash the ammonia from the leaves. So far growth is very regular. Moisture samples and growth measurements—20 samples and 20 sticks per acre—are being kept, and with the aid of a wilting graph, water

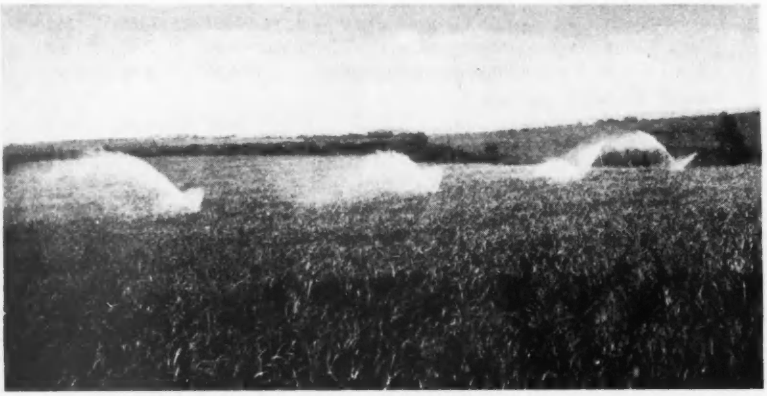

Fig. 31.—Revolving irrigation sprays at Waialua Plantation. The sprays are spaced 100 feet apart and revolve once in 5 minutes, delivering water at 60 lb. nozzle pressure.

is applied before maximum growth ceases. This is opposed to another part of the field where 6- and 8-day intervals are allowed between wilting point and watering.

Soil sampling is done in the cane row, but not right against a stool. The measured stick is selected alongside the soil sample position. Soils in this area have a maximum field capacity of 40 per cent, and a wilting point of 30 per cent. moisture—actually a worse condition than the Queensland volcanics.

Fig. 32.—Closer view of sprays illustrated in Fig. 31.

Figs. 33 and 34.—Simple spray fluming joint in use at Waialua Plantation. The joint is locked by a single lever movement, as in Fig. 34.

Fertilizer Practice in Hawaii.

For many years Hawaii has been known for the large amounts of fertilizer used per ton of cane produced, and the writer was very interested in endeavouring to find out the basic reason for the practice and what experimental data were available in support thereof. The whole of the Hawaiian soils are volcanic in origin, normally red in colour, but varying much more considerably from place to place than do the Queensland volcanics. On account of the island topography and the incidence at higher elevations of heavy rainfalls, many of the soils on the lower levels are transported soils. Also near the sea coast—Ewa for example—certain coral soils exist mixed with only a small proportion of true volcanic loam transported from the neighbouring hills. In other places—Pahala on Hawaii—the soils are very dark brown rather than red. But taken as a complete unit it would be expected that they should react somewhat similarly to fertilizer, as do all the Queensland volcanics. Investigation of field trials on a number of plantations, however, and examination of the fertility survey maps, show marked differences from block to block and from plantation to plantation, in fertilizer requirement—principally in relation to potash and phosphate deficiencies. Certain blocks and plantations require large phosphate applications, while others react to large amounts of potash. It is felt, in the absence of evidence to the contrary, that much of this differentiation is due largely to past history of the plantations rather than to inherent soil differences. Whether this be correct or not, the most interesting feature of the fertilizer practice is the extraordinarily large amounts of fertilizer used. The amounts of N, P, and K used on the various plantations are covered by the following figures:—

N	150—300 lb. per acre
P_2O_5	150—300 lb. „
K_2O	120—300 lb. „

Nitrogen is used almost exclusively as sulphate of ammonia, phosphate as super, basic super, or ammonium phosphate, and potash as muriate of potash. It is therefore common to find a plantation using 1,200 lb. sulphate of ammonia, 1,200 lb. superphosphate and 600 lb. of muriate of potash, or a total of 1½ tons of fertilizer per acre. The crop produced under these conditions at say 22 months old, would approximate to 80—100 tons per acre—sometimes higher.

Crops approximating to these tonnages are occasionally grown on plantations in Queensland, and, in South Queensland certainly, are not supplied with anything like this amount of plantfood. However, one is scarcely in a position to draw conclusions from a comparison of these figures since in Queensland such large crops have certainly not been produced over a long period of years as has been the case in Hawaii. Nevertheless, and in spite of authoritative opinion to the contrary, the writer feels that applications of nitrogen, at least, are unduly heavy and that reduction to, say, 125-150 lb. would be productive of more profitable results. To the visitor it would appear that too much emphasis is placed on tonnage of cane produced per acre.

Determination of fertilizer requirements is carried out in plantation laboratories. Virtually every plantation employs an agriculturist and

maintains a laboratory wherein chemical tests of fertility may be carried out by the so-called "R.C.M." (Rapid Chemical Methods). For the purposes of these tests the plantation is usually divided into 5-acre units and a sampling station of ¼ acre marked off within each unit. Samples are collected within each station by a standardised method, subsampled and taken to the laboratory. The analytical figures, representing a test for each 5 acres, are set out in a map and the quality and amount of fertilizer for each field is determined by reference to these maps.

After harvesting the sampling is repeated in the same stations and fresh maps made.

Cane Harvesting and Loading.

A great variety of harvesting and loading methods were observed in Hawaii and a brief description of the more important is given below:

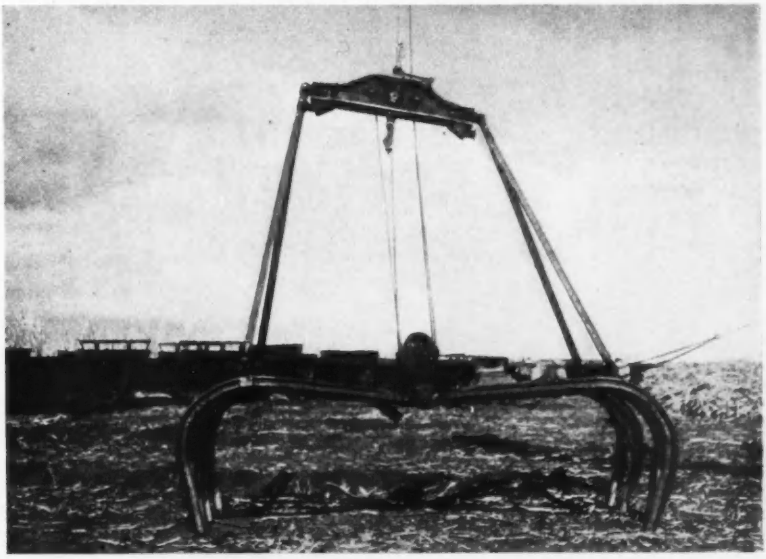

Fig. 35.—Close view of the grab of the Ewa grab harvester and loader. This unit picks up 1½ tons of cane and loads it on to a truck alongside.

(1) *Grab harvesting and grab loading:*

This method is the most important one on the island of Oahu, and being of late development is exciting the most interest. Practically all Hawaiian cane is recumbent and very tangled. The grab harvester seen at Ewa plantation (*see* Fig. 35) was working in a flat field with a crop of 90 tons per acre. The crane which operates the grab is mounted on a turntable built on to a caterpillar tractor. It is essentially the same implement as a mechanical shovel frequently seen loading stone from quarries, except that the grab replaces the shovel on the boom of the

crane. (*See* Fig. 35-38.) The grab is supported from the movable boom by cables, which in turn are counterpoised to retain a tension on the cable at all times. The grab is hinged at the top, and each side consists of four prongs each about 3 in. in diameter and with blunt ends. The grab is lowered to the ground, closed, and as it rises pulls a bundle of cane of about 4-6 cwt. with it, breaking it off near ground surface. This is dumped on top of adjoining cane and the double heap picked up and so on till about 1½-2 tons are in the grab. This is then swung around by the crane and dropped into a truck on the portable

Fig. 36.—The grab harvester in operation, grabbing and breaking off a bundle of cane.

line alongside. Two full grabs fill the truck—which holds from 3 to 4 tons. Five grab machines harvest and load 20 tons per hour each, thus supplying the mill with its requirements of 100 tons per hour. They work 24 hours per day. Following the grab are six men who chop off any sticks missed, trim long stubble, and throw all missed cane into a heap. Periodically the grab is swung around to pick up these heaps. Thus with one man on the grab, a total of seven men harvest and load 20 tons per hour. The driver and six men work on a contract basis of so much per ton of cane. The field is left remarkably clean afterwards; some stubble upwards of 4 in. high is apparent, but owing to the age of the base of the stalks, the burning of same, and mechanical damage, it is improbable that any viable buds remain thereon. Already an experiment has been initiated in which cane was cut below the ground, level with the soil surface, 2 in. above, 6 in. above, and 1 ft. above, to estimate the effect of ratooning.

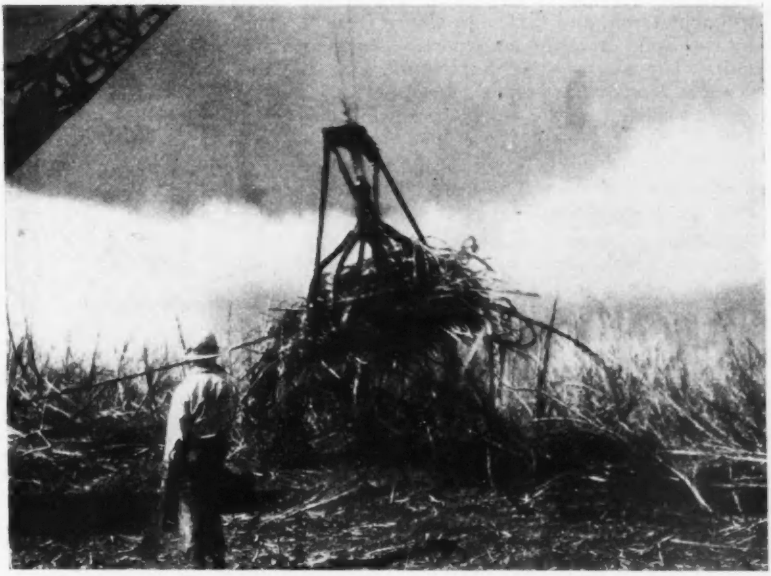

Fig. 37.—Grab harvester lifting a load of cane preparatory to dumping it aboard a truck.

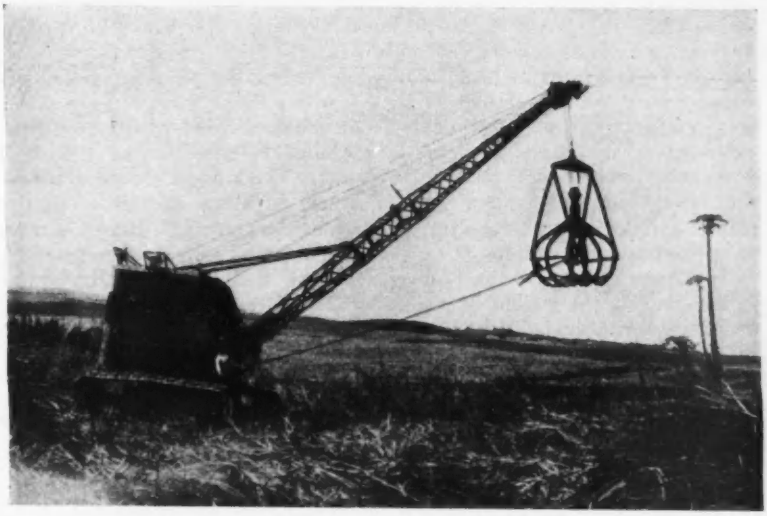

Fig. 38.—The North West cane grab harvester and loader in operation at Paauhau Plantation. This light type grab is powered by a V8 engine and picks up loads of approximately 15 cwt.

The cane trucks as loaded above with untopped cane, extraneous unburnt trash, and dirt, and stones from the field, are taken to the mill by the usual tramline transport. The plantation, of course, adjoins the mill. The total cost of harvesting, loading, and transport to the mill is about 45 cents. per ton of cane. Seven of the grab harvesting machines are on Ewa; five are working constantly, one under normal overhaul, and one spare is kept for sudden breakdowns. On Paauhau plantation there is a smaller type of grab harvester and loader. It is equipped with a Ford V8 engine and a smaller size grab than the Ewa one. (*See* Fig. 38.) This implement lifts about 15-20 cwt. in each complete operation, whereas the Ewa type lifts 1½ to 2 tons. This costs 8,000 dollars as compared with 15,000 dollars for the Ewa type.

Many fields were inspected where the ratoons were already well away and the growth appeared perfectly normal. Hawaiian plantations always replant misses in ratoon crops as well as in plant crops. It is found that the percentage of supplies has risen from the previous 5 per cent. to a figure of about 8 per cent, on account of the grabs. This apparently high percentage of supplies is accounted for by the fact that at Ewa cane is planted very thickly—with considerable overlapping of plants—and every small gap without ratoon shoots is filled up. Although the fields observed appeared to be very clean after the grab harvesting operation, it was stated by some persons that actual trial has shown that up to 2 and 3 tons of cane per acre are left lying on the field. This may happen when the gang following up is reduced in number.

(2) *Drag line harvesting rake:*

This is the latest development of the mechanical harvesters. In July, 1938, the Waialua Agricultural Company devised this Watson harvesting rake as a more economical means of cane harvesting. (*See* Fig. 39.) It has since been adopted by a number of plantations and consequently the rake design varies somewhat from place to place. The complete unit consists of two caterpillar tractors fitted with mechanical cable winches. These tractors work along the direction of the cane rows at a distance of about 75 feet apart. The rake is dragged across the rows from one tractor to the other, breaking off the cane in transit and delivering a rake-full of cane near one tractor. Here the rake is tripped and the bundle of cane left in position. Next both tractors move forward slightly, the rake is run back to the first tractor again and in transit the weight of the rake flattens down the cane; starting its forward run again it rakes up and delivers another heap of cane as before. The routine is very fast. Haul-in speeds of the rake are as high as 300 ft. per minute, and the normal harvesting rate is 1 acre per hour. At the completion of harvesting, the cane is in rows of heaps running the length of the field. The conventional grab loader is then employed to load these heaps into trucks on portable line. (*See* Figs. 40, 41, and 42.) The out-haul tractor for the rake is usually of 30 h.p., but the inhaul tractor varies with the speed of inhaul required. For a speed of 300 ft. per minute it is stated that a 75 h.p. unit is required.

This method is similar to grab harvesting in that the cane is broken off at or near ground level. By means of the rake, however, it has been

Fig. 39.—Drag line harvesting rake. This implement operates between two tractors on power winches and cable. It harvests about 1 acre per hour and leaves the cane in piles at one side of the field.

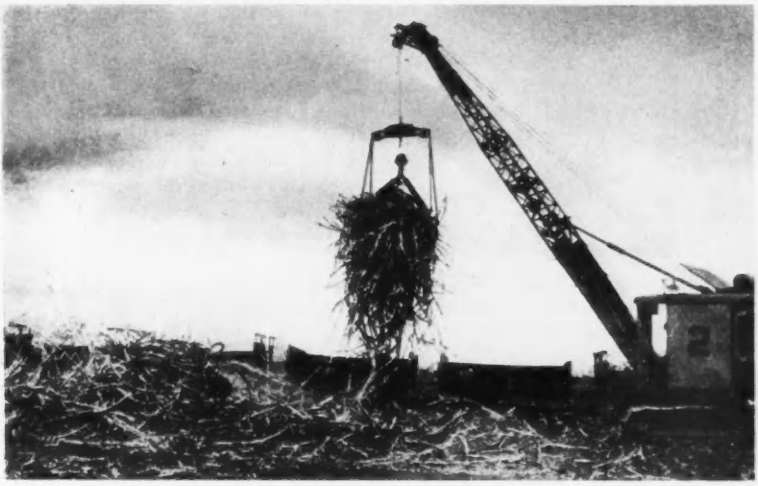

Fig. 40.—Grab loading unit in operation after rake harvesting.

possible to speed up to a marked extent the harvesting of cane. There is some division of opinion among plantation men as to which method gathers up the most dirt and trash with the cane. As for tops and trash, Mr. Maze states in his report "there appears to be no good reason to believe that either the grabs or the rake will gather anything less than all that is in the field."

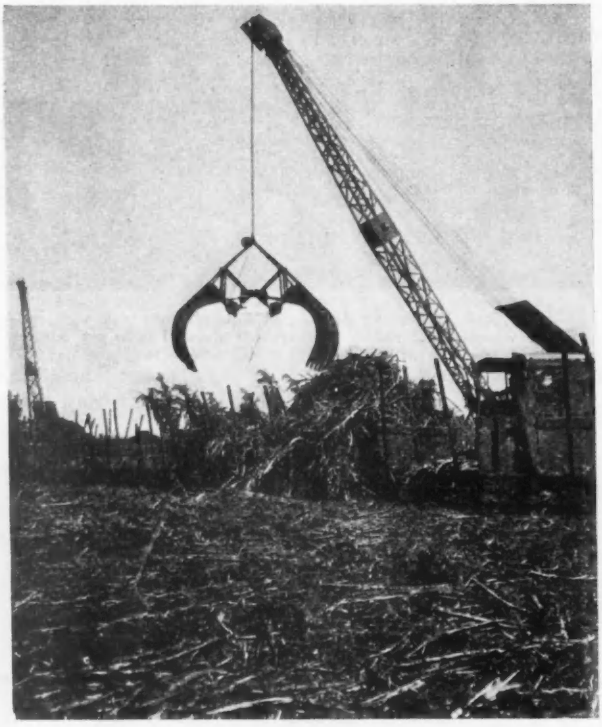

Fig. 41.—Following rake harvesting, cane being loaded into open sided trucks fitted only with stanchions.

The rake leaves the field in a very clean condition considering the method of harvesting, and the inventor is working on improved models, which will no doubt increase the efficiency of the implement. Actual reliable costs were not available, but it was freely stated that the method was cheaper than grab harvesting and loading.

These two harvesting methods are both being widely used to-day (Ewa grab harvested over 99 per cent. of its crop in 1938) and, so far as the field man is concerned, satisfactorily solve the problem of harvesting the crop. Great variety exists, however, in the methods of loading and transport. In both the above methods of cane harvesting it was stated that grab loaders dropped the cane into railway trucks

on portable lines. On some plantations the motor truck appears to be displacing railroads and on several plantations the contour of the country does not allow of tramway construction. It is in the type of motor truck transport that progress has been greatest. For those plantations where local conditions permit, trucks with 24-feet bodies, holding about 8 tons, are used for hauling direct to the mill. (*See* Fig. 40.) These trucks are, as a rule, powered by diesel motors and are equipped with three driving axles. In most cases the rear axle is fitted with dual wheels. All three axles are power driven.

Fig. 42.—Grab loading unit loading into trucks with built-in sides.

On plantations where, for various reasons, it is not advisable to haul direct to the mill, the trend appears towards smaller trucks equipped with dump bodies. These trucks generally haul from 3 to 4 tons. The cane is dumped direct into a railway truck by means of a ramp. Traction on these trucks appears to be just as important as on the larger trucks. The all-wheel drive is most satisfatcory. On one plantation a 3-axle drive diesel truck fitted with a spreader body is being used. This is used to haul and spread filter press mud direct on to the fields. It might be mentioned that when an 8-ton load is hauled, the matter of transfer hoists becomes of great importance. Hawaiian Agricultural Company has developed a satisfactory hoist, which has been adopted by several other plantations. At Kohala plantation a most ingenious truck, known as the self loader, was seen in operation. This truck can be seen in the accompanying illustrations

Fig. 43.—Cane being loaded into a 6-wheel, 8-ton motor truck at Hawaiian Agricultural Company.

(Figs. 44-47.) It is used on certain plantations where cane is hand cut. The cane is piled by the cutters on top of slings in the fields in heaps of about 2½ to 3 tons. One side of the truck is let down, as shown, to form a sloping ramp. A winch driven from the truck engine pulls the heap of cane up into the truck body. Then the next heap is pulled in on top

Fig. 44.—Self-loading truck. The cane is heaped in the field on top of slings, the side of the truck is let down as a ramp and the bundle of cane is hauled up the ramp into the truck by a winch operated by the truck engine.

Fig. 45.—Self-loading truck. A second bundle of cane is hauled on top of the first, and so on, to a load of 4 tons.

of the first, and the 6-ton truck is fully loaded in about three or four minutes. However. in spite of their ingenuity they are not a success owing to the tremendous strain exerted on the chassis by hauling these loads out on to the truck, and they are to be replaced by grab loaders. The trucks are diesel motored. Comparing harvesting costs, the grab system costs 45 cents per ton from standing cane to the mill carrier. The self loading truck costs 70 cents a ton after the cane is cut down. The strain on the trucks is heavy and maintenance is high.

Fig. 46.—Self-loading truck fully loaded.

A quite recent introduction was an International truck fitted with a Heunesee crawler attachment and Frenhauf semi-trailer. The crawler attachment is fitted with Goodrich rubber track and a life of approximately 5,000 miles is claimed for this truck. The crawler frame has been improved by spring mounting the front idler and truck wheels. The semi-trailer, though not used extensively as yet in Hawaii, has come to stay. The short wheel base truck has attached to it the semi-trailer body for cane transport and loads of 8 and 10 tons are easily conveyed by this means. The semi-trailers are more common in Louisiana and generally carry a number of slings of cane from field to either railway cars or the mill.

The semi-trailer would possess definite advantages in Queensland where long haulage is necessary between farm and rail derrick, or between farm and mill. It is not unusual in Queensland to find farmers who haul their cane by motor truck seven or eight miles to a mill. Much time and expense would be saved by loading separate slings on a semi-trailer of, say, 8 tons capacity and doing one trip to the mill instead of three or four. The writer understands that Fairymead Plantation already has a couple of semi-trailer trucks working successfully with loads up to 9 tons.

On account of the heavy loads carried and the difficulty in obtaining traction on some of the wetter plantations, the multiple axle drive is largely employed. On one plantation were used 3-axle drive diesel trucks equipped with Timkin dual rear axle drive and front wheel drive. These trucks are also fitted with Westinghouse air brakes and with 10·50 x 24 mud and snow tyres.

Under test at present are also the trucks fitted with railway track on the frame and capable of carrying two small cane trucks. This is the same system as is used in some parts of Queensland. The truck is fitted with a power winch for hauling the cane trucks up the track.

The tendency, however, all over the island is to grab load into either railway trucks or motor trucks—eliminating all hand loading—and in the case of motor trucks, to have a simple means of transferring the cane to railway trucks. With regard to the latter, the method most favoured is the ramp and dump motor truck. Ramps are built at convenient points along the permanent lines, the loaded motor truck mounts the ramp and tips its load into the railway truck below. This is even cheaper than transfer hoists. The principal objection to these methods of handling is that the cane is only loosely packed in the trucks and quite a large cane truck is needed for a 3 or 4 ton load. This loose packing, on the other hand, allows of much of the dirt collected by grabs being shaken out of the cane by the vibration of the truck.

Another method of cane transport which is, however, of only passing interest to the Queensland grower, is by means of flumes. (*See* Fig. 48.) On such plantations on the island of Hawaii where mountain water is abundant and other means of transport difficult, the cane is flumed to the mill. The flumes as used on the fields must be portable and are usually of 14 inches x 1 inch timber, two pieces being attached at right

Fig. 47.—Heaps of cane in the field ready for the self-loading truck.

angles to make a V-shaped trough. Lengths of such flumes, supported by trestles to give the required fall, can be moved from field to field as harvesting progresses. The cane is cut into 3-feet lengths by the cutter, tied in bundles, and carried to the flume. It is then untied and thrown in, the flow of water carrying it along. As the mill is approached, these flumes join larger, permanent ones, until by the time the mill is reached, the main carrier is a flat bottomed trough some 4 feet wide and 4 feet to 5 feet deep. The flume delivers the cane right on to the carrier, the water running away below the mill. It will be realised that a tremendous amount of water is required for this method of transport, since high velocity is required to keep the cane moving.

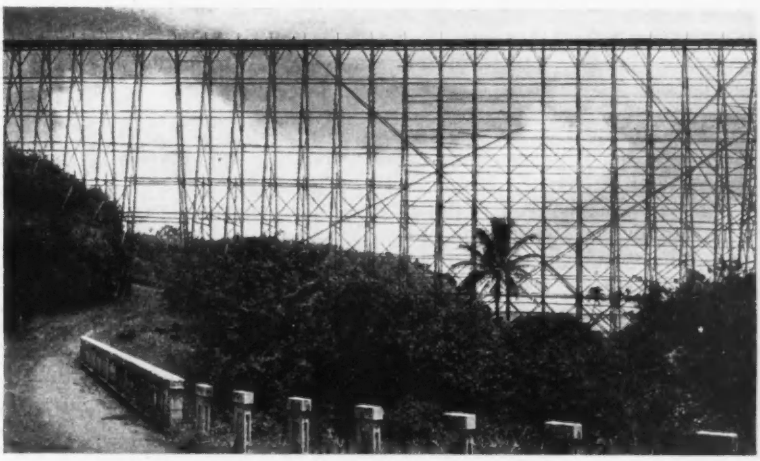

Fig. 48.—Fluming for water transportation of cane mounted on a trestle for the purpose of crossing a ravine.

In the case of a mill breakdown, a good system of flag signals or telephone communication causes watchmen to shut off the water and cease loading of cane into the flumes.

With this method of transport, the weight of cane coming to the mill is not obtainable by the ordinary methods. It was stated above that the bundles of cane are tied up before being carried to the flume. A certain proportion of these bundles are hand weighed for average weight and then each cutter is credited with so many bundles and the total weight calculated.

So rough is some of the Hawaiian cane country that certain of these main flumes have been constructed across deep gulches, the flumes being on trestles as high as 170 feet.

Pests and Diseases in Hawaii.

Rats.—Rats still present a pest problem in Hawaii, although they do not appear to occur in plague populations such as are experienced periodically in Queensland. The most favoured method of control at present is the pre-baiting method; fundamentally this consists in setting out feeding stations with unpoisoned food and then, when the rats have become habituated to the stations, poisoned food is suddenly substituted. This method of poisoning was widely discussed at the conference of Cane Pests Boards held at Meringa last year, and it is understood that some investigation is now being carried out under Queensland conditions.

Pythium Root Rot.—This once serious disease is now of little economic importance on account of the substitution of resistant varieties. This disease is greatly accentuated by phosphate deficiency and heavy applications of nitrogenous fertilizers, molasses, &c. It appears that susceptibility to this disease may be to a considerable degree associated with the phosphate economy of any particular variety, and in many cases satisfactory control may be achieved by a suitable dressing of phosphate. E.K.28 has been found to be the most susceptible variety grown in Hawaii—a point of interest to Lower Burdekin growers who occasionally have ratoons of E.K.28 attacked by pythium root rot.

Eye Spot.—The leaf-spot disease, eye spot, which does not occur in Queensland, is upon occasion still responsible for damage in Hawaii and varietal resistance trials are an ever-present necessity. A considerable amount of work now being carried out is directed towards the testing of young seedlings in the "flat" stage. By this means thousands of seedlings could be tested in a very small space, but no results of the experiment are yet available.

THE LOUISIANA CONFERENCE.

After registration of delegates, a business meeting was held on the afternoon of the 24th October. This meeting merely outlined the programme of the Conference and gave delegates instructions as to details of transport, &c. In the evening a sugar film was shown, depicting certain phases of the Louisiana industry, and particularly stressing the wind-rowing of cane prior to a freeze.

On the 25th a short visit was paid to the United States Industrial Alcohol Company's plant near New Orleans; some notes on this plant are found elsewhere in this report. In the afternoon the milling section went to Gramercy Refinery, while agricultural delegates were taken to Reserve Plantation. The Reserve test field contained a series of experiments with varieties, the plant cane being two replications of 4-row plots of five varieties, the first stubble being two replications of 3-row plots of seven varieties, and the end stubble two replications of 3-row plots of seven varieties. Small propagation plots of newly introduced varieties were also inspected.

An historic cane garden, arranged by the manager, Walter Godchaux, included such canes as Creole, Otaheite, Palfrey, Louisiana Purple, Red Striped, Green Striped, D.74, Cayana, and many P.O.J., Co. and C.P. canes.

On 26th October the programme comprised a visit to Chalmette Refinery in the morning and to the Celotex plant in the afternoon. Having seen the Canec factory in Hawaii, Mr. Blomfield and the writer took the opportunity of calling on the New Orleans agent for the Castagnos Cane Loader. The agent, Mr. Wiggin, took us out to the manufacturing plant, and called *en route* at Thompson Implement Works where most Louisiana field implements are manufactured. We also, at Mr. Thompson's offer, saw a demonstration with the Munson-Thompson wind-rowing machine, and then went on to Terrebonne Mill, where the Munson cane cleaner and chopper were installed on a special mill carrier. Had the Conference itinerary been adhered to, none of these items would have been seen.

On 27th October the Conference left New Orleans by 'buses, and during the day the mill delegates visited Georgia factory and refinery and Southdown factory, while agricultural delegates visited Houma Experiment Station. This is a Federal Station establishment in 1925 by the United States Department of Agriculture, Division of Sugar Plant Investigations. This area is approximately 100 acres, and the buildings are well equipped laboratories and offices for pathologists, entomologists, chemists, and physiologists. Field experiments are along the lines of soil fertility experiments, effect of fertilizers on maturity, yield and quality of cane; there is also a division of drainage which considers influence of depth of draining, spacing of ditches and tiles, &c. The pathologists do the major amount of experimental work—principally on red rot and mosaic—while the plant physiologists are principally concerned with studying the effects of wind-rowing, under a variety of conditions, on all new varieties of cane.

Dr. Summers demonstrated his method of mosaic inoculation, and gave a short lecture on the strains of the virus known up to the present. These are discussed separately, as are also the tests carried out by Dr. Abbott on red rot resistance in new seedlings.

That evening the delegates spent in Lafayette.

On the 28th the agricultural delegates visited Billeaud test fields, Albania, and Camperdown plantations. On all three of these plantations were inspected field experiments similar to those at Reserve, in

which a number of new varieties were being tested against Co.290 and Co.281 in small 3-row plots with two replications. In the Billeaud district there are upwards of 2,000 farmers supplying to the factory 100,000 to 125,000 tons of cane. Of the total acreage about 90 per cent. is under Co.290, but this is an unusual position.

On the 29th October Greenwood plantation, Rienzi plantation and Cinclaire test fields were visited; these were merely a repetition of what had been seen before. At Rienzi, in contrast to Billeaud, Co.281 constitutes 28 per cent. of the crop, and Co.290 only 15 per cent., the remainder being under later seedling canes. Cinclaire has 30 per cent. Co.281 and only 6 per cent. Co.290.

Baton Rouge was reached that evening, and the Conference proceedings occupied all the following week.

At the final business session of the Conference a resolution was carried rescinding that passed at the Brisbane Conference and once again making the Conference a triennial event.

No invitation was received for the 1941 Conference. Cable communication with Philippines resulted in their refusal to invite the Conference there, and at the time of terminating the Louisiana meeting India had expressed the wish to have the matter left open for three months for the consideration of local interests. The Mexican delegates also expressed their willingness to issue an invitation if Conference were agreeable to meet again in a country so close to Louisiana. Finally a motion was passed, sponsored by Mr. Agee, that, failing an invitation from a sugar cane growing country within twelve months, the next meeting be held in London or Amsterdam or some other European capital.

CANE SUGAR PRODUCTION IN LOUISIANA.

Cane Cultivation.

The Louisiana cane lands are all part of the old Mississippi flood plain. They are flat, alluvial lands of varying texture, but all more or less heavy. Owing to their rather high clay content, and the almost invariable clay subsoil, they are not well drained, and the entire agricultural practice of the Louisiana canegrower is defined and bounded by this lack of good drainage.

Preparatory cultivation follows approved agricultural practice of other countries. Disc ploughs are used on all except the smallest farms, and multiple disc ploughs on the larger plantations and holdings. The larger growers also use tractor power as much as possible, while the smaller grower depends on his mules. When a suitable seed bed is prepared by ploughing and harrowing, the entire canefield is ridged by using double mould-board ploughs and finishing with disc cultivators. The finished field shows the ridges 6 feet apart, and between the ridges a drain or channel. The height from channel bottom to ridge is some 15 inches. A drill is then opened along the top of the ridge, the cane is planted by hand, covered, and a roller run over it to compress the soil and make good contact with the plant. Subsequent cultivation aims

at controlling weeds in the channel and on the ridge, and for this purpose disc cultivators of the Cotton King type are principally used. Germination is slow on account of the long winter period (see below), and to prevent the red rot damage which enters the cut ends, long setts are used—2 feet 6 inches to 3 feet. Consequently a heavy cover is applied to the sett to prevent the turning up of the ends as the sett dries out. Until the last year or so all cane planting took place in autumn. The cane would germinate, primary shoots develop, and the freeze would cut it back to the ground. During the dormant winter period, pythium would ruin the small number of roots developed, and when spring came there would be found a heavy loss of stools for this reason. Consequently the system was altered so that planting was done in late summer. Germination was more rapid and more sure, and stooling could take place before the advent of the freeze. Then the whole stool would be cut back by the freeze, but underground would be a fully developed stubble instead of just a primary shoot. A larger root system prevented such damage from pythium as previously occurred, and with the advent of spring numerous shoots would come away to grow unchecked. To all intents and purposes, then, we might quite correctly state that "Louisiana grows only ratoon crops."

With the advent of spring, disc harrows are run along the interspace channels and throw a lot of soil from the ridge sides into the channel; then follows a double mould-board plough built on a frame straddling the row and ploughing away from each side of the cane row to allow the soil to warm up after the winter. As soon as shoots appear the process of ridging described earlier is repeated, thus returning the soil from the channels to the ridges. After harvesting the crop and burning the trash, the ground surface is left entirely undisturbed because the next winter has arrived. When spring comes again, the process described above is repeated for the first ratoon crop. At this stage fertilizer is applied in the plough-away furrows before the soil is returned to the ridges.

Almost universally one plant and two ratoon crops are grown. After the final ratoon an implement is used to plough out, which differs in principle from that normally employed in Queensland. It consists of a double mould-board plough, preceded by a revolving disc coulter. The disc coulter cuts through the middle of the stool and the two mould-boards then throw one-half of the stool to the left and the other half to the right, thus ploughing the ridge into the interspace channel. During the following summer it is standard practice to grow legume crops on all fallow land, soy beans, vetches and cowpeas being the crops principally used. These are almost all ploughed under, very few plantations now cutting them for hay as was the practice heretofore.

Fertilizer Practice in Louisiana.

The Mississippi delta soils are well known for their fertility, and generations of cane growing appear to have made only slight inroads on the nutrient supply available. In the majority of the cane areas no response to potash or phosphate is obtained, but all soils respond to applications of nitrogen. The Iberia heavy clay soil and the Lintonia

silt loam show slight, though significant, responses to potash, but these are the only two soils which do so. In only isolated cases, again on the Lintonia soil, have phosphate responses been obtained.

The general practice therefore is, as described above, to grow legume crops during the fallow period. At planting time many growers and plantation owners apply cyanamide in the drill at the rate of 100-125 lb. per acre, and invariably the ratoon crops are fertilized with cyanamide at the rate of 200-250 lb. per acre. In the few cases where phosphate is used, a 12-8-0 mixture is applied at the rate of 250-300 lb. per acre. Potash deficient areas are dressed with 12-0-4 mixtures. The writer considers that too much nitrogen is being used on plant crops, particularly as they are preceded invariably by good legume crops. The application of further nitrogen to the plant crop serves only to accentuate the low purity juices obtained in Louisiana as a result of the short rapid growing season. It was not clear to the writer why cyanamide is used. It may be one of price per unit of N, or it may be a long standing recommendation from the pathologists or agriculturists to inhibit the inroads of red rot in sett or stubble.

Cane Harvesting, Cane Loading and Transport in Louisiana.

Louisiana is remarkably well advanced in these phases of sugar production, and the methods employed there are a definite lead to Queensland, which latter country will undoubtedly develop along lines of reducing harvesting, loading and transport costs.

Harvesting and loading in Louisiana are regarded as two separate jobs; and since harvesting is still done by hand cutting, no further mention will be made of this phase of the work, except in a later paragraph which deals with wind-rowing (*q.v.*).

Loadings: The agricultural system employed in Louisiana, by a very fortunate circumstance, lends itself admirably to the development of a very fine loading system. The ridged contour of the cane field is taken advantage of in the system. All cane is cut green. At cutting time the tops and trash are thrown by the cutter into one of the interspace ditches, and the bundles of cane laid across the ditch so that the butts and tops rest on adjacent ridges. The cane bundles are made larger than those in Queensland, being approximately 120 to 150 lb. in weight.

The Castagnos loader (*see* Figs. 49 and 50) is then used for loading into trucks. This loader is merely a crane-type boom carrying a cable and a small grab, and operated by a 7½ h.p. engine. The entire outfit is mounted sometimes on a flat top waggon (similar to a flat top one-ton motor truck) drawn by mules. The later types are pneumatic tyred. The 7½ h.p. engine operates a winch which is equipped with friction brakes, and the winch in turn operates the cable and grab. In action the waggon carrying the loader moves parallel to the cane rows, with wheels in the ditches and straddling the cane ridge. The grab picks up a bundle of cane from the next ditch on the side, swings it around to the opposite side and deposits it in a cane truck, which also moves along at the same rate as the loader.

Fig. 49.—Close-up of the grab of the Castagnos cane loader used in Louisiana.

Fig. 50.—Castagnos loader (older type) at work. The boom is on an extension third wheel. Note on right the cane has been thrown by the cutters across the ridges so that the grab can pick it up without adhering trash or dirt.

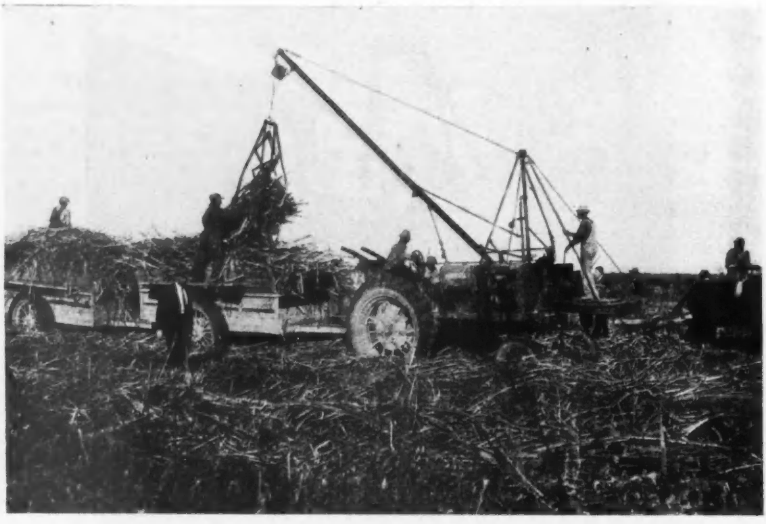

Fig. 51.—Loading cane into pneumatic tyred waggons in Louisiana. Each waggon holds 2 tons, and two waggons are drawn by a high-speed tractor at 20 m.p.h.

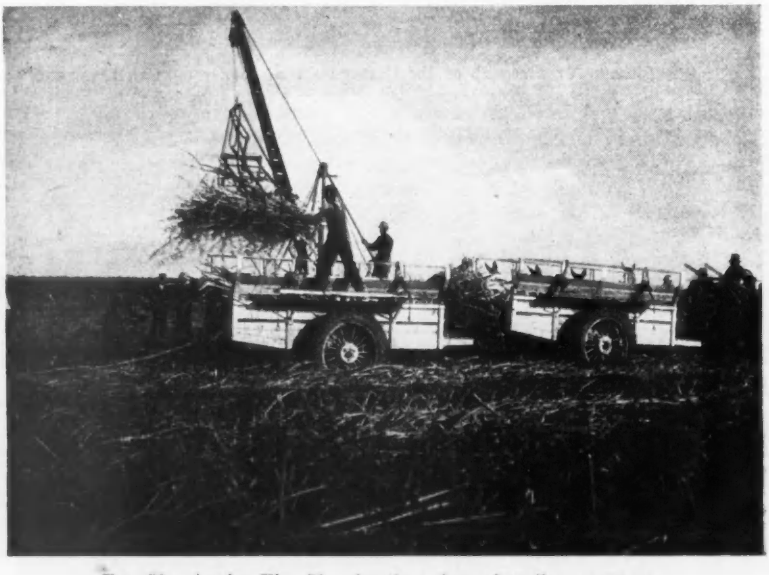

Fig. 52.—As for Fig. 51. Another view of trailer waggons.

This loader, in a 30-35 ton crop of cane, can load 30-35 tons per hour. In operation one man is on the loader and works the engine and winch; three men are on the ground, one leading the mules which draw the loader and two picking up odd sticks which the grab has missed. It will be understood that the method of laying the bundles of cane across the ditch allows the grab to take hold of the bundle without picking up any trash or dirt.

The cane trucks in standard use are shown in accompanying illustrations. (Figs. 51-53.) It will be noted that a pneumatic tyred tractor draws two trucks, also pneumatic tyred. These tractors can travel with two loaded trucks at 20 m.p.h. from the field to the transfer derrick, at which point the cane is transferred to railway trucks. Each of the small trucks carries two tons of cane and it is loaded on top of a sling for ease in transfer.

Fig. 53.—Loader putting a sling of cane on a motor truck with semi-trailer carrying 8 tons of cane. The first section is a 2-ton truck on a shortened chassis.

One Castagnos loader keeps four tractors going, each tractor drawing two trucks or four tons of cane. The cost of the loader in America, built on a truck with four pneumatic tyres (the rear tyres

being of the giant tractor type) and with 7½ h.p. engine, is 1,100 to 1,300 dollars. Some costs obtained on an average plantation are as follows:—

	Cents per ton
Cutting (including water boy and all charges)	75
Loading with Castagnos loader	9
Derrick hoist (including carting to derrick)	4

The cutters cut, on an average, two tons per day of eight hours (all thin canes, cut green).

This loader appears to have definite direct application to parts of Queensland where irrigation furrows would allow the cane bundles to be easily picked up by the grab. It could be used for loading into portable line trucks or into motor trucks providing some care were taken in placement of the bundle. To the writer's mind this loader is the obvious first step in the reduction of harvesting and loading costs, were mechanical handling contemplated.

Where the farm or plantation is close to a mill, the transfer derricks for railway trucks are not used. The tractor-drawn cane waggons are taken direct to the mill yard, the slings unloaded by derrick on to the cane heap in the mill yard, and then transferred by a travelling crane to the mill carrier as required.

Wind-rowing Machine and its possible application as a Cane Harvester.

In Louisiana the harvesting period is quite different from that of other countries. Owing to the severe winter temperatures, all cane has to be cut down before a severe freeze takes place, which means that harvesting time precedes the winter. It was found that the effect of

Fig. 54.—Wind-rowing machine in operation in a Louisiana canefield.

a freeze on standing cane is to kill the growing point and all the buds and promote rapid decomposition of the cane—just as occurs in South Queensland after a severe frost. It was also found, however, that if cane were cut down—tops, trash and all—before the freeze, and laid in the ditches in between the rows in such a way that the tops of one bundle covered the sticks of the next (*see* Fig. 57) and so on, the cover of tops protected the buds from freezing and little if any, deterioration of the cane resulted. This process is known as wind-rowing. Then, as the mill is able to take the cane, it is picked up, topped and trashed, and transported as usual to the mill. (*See* Fig. 54.)

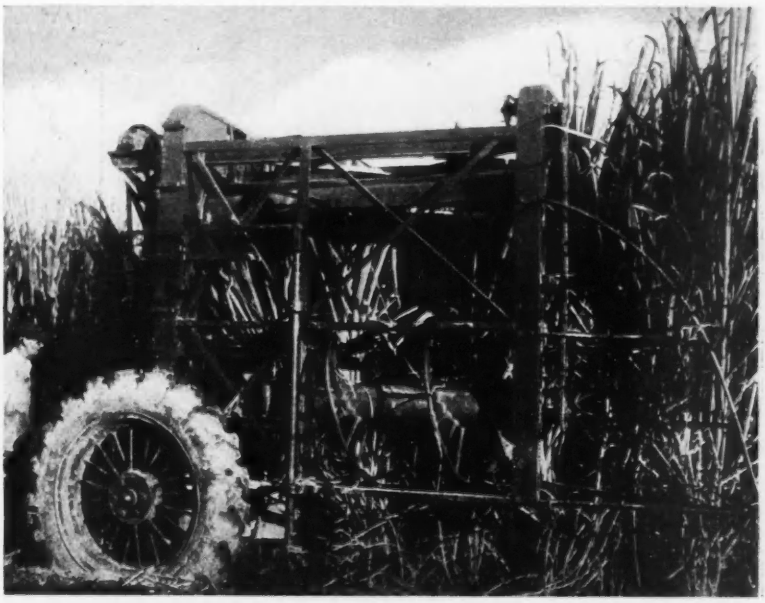

Fig. 55.—Close-up of wind-rowing machine. The machine has one front wheel and two rear wheels. The tractor is 12 ft., so that two rows of cane are straddled by the rear wheels while the front wheel runs in an interspace. Guides in front straighten leaning cane.

It will be obvious, however, that if a freeze developed when only two-thirds of the crop had been harvested, there would not be sufficient labour to cut down and wind-row all the remaining cane in a couple of days. Consequently there is always some cane which is destroyed by the freeze, resulting in a serious loss to the grower. Then came the idea of the wind-rowing machine. Several designs have been worked on for many years, but it was only in 1938 that a successful machine was invented. The writer saw this model in operation on two occasions (*see* Figs. 55-57), and has no doubt regarding its ability to do a satisfactory and economical job.

It has been mentioned previously that a 6 ft. interspace is standard practice in Louisiana. The machine consequently is built with a 12 ft. track so as to straddle two rows of cane. It cuts off the cane at the soil

surface, making a perfect job of the cutting, and deals with two rows simultaneously. All sticks from both rows are carried through the machine and placed in the straddled ditch so that all lie in the same direction, while the sticks are entirely overlapped by tops.

The machine was operating in a 35-ton crop of Co.290 and was cutting and wind-rowing 1½ acres per hour, equalling over 46 tons of cane per hour. The machine travels 1¼ miles per hour, is pneumatic tyred, and the entire mechanism, both for moving the machine and cutting the cane is driven by a Ford V8 engine. The cost is not quite definite yet, but will be in the neighbourhood of 1,500 dollars.

Fig. 56.—Sample of work done by the wind-rowing machine.

So much for the machine for wind-rowing purposes. The inventor maintains that he can incorporate a fairly satisfactory topping device. This would be along the lines of a mechanically driven cutter built in front of the machine, thus topping the cane before it is cut. The present idea is to have a second man on the machine to raise or lower this cutter manually as the average height of the cane stools varies. It is admitted, of course, that sticks in a given stool vary in length, but if a stool were cut at an average height we would probably obtain stalks some of which were cut 2 inches too high and some 2 inches too low. This would not be a serious detriment to mill work. With straight cane such a machine, combined with the Castagnos cane loader, and operating on burnt cane, would appear to constitute the closest approach to date to successful mechanical harvesting of cane.

Frost Resistance of Canes in Louisiana.

The Experiment Station at Houma employs a research plant physiologist for the sole purpose of investigating the deterioration of cane subsequent to a freeze. The problem in Louisiana is fundamentally different from that of frosted cane in South Queensland in so far as they wind-row all their standing cane just prior to a forecasted freeze or just after the incidence of an unexpected drop in temperature. The problem there is to find canes which will resist deterioration while lying in the wind-row rather than canes which retain quality while standing after a killing frost. Some brief observations from their work indicate the following points:—

(1) The wind-rowing and keeping qualities of unfrozen cane of seven commercial varieties were considered. These were divided into three groups according to their resistance to inversion of sucrose:—Group 1, resistant to inversion under a wide range of storage and wind-rowing conditions: Co. 281. Group 2, showing less resistance than group 1: Co. 290 and C.P. 29/116. Group 3, showing considerable susceptibility to inversion in comparison with groups 1 and 2: C.P. 807, C.P. 28/11, C.P. 28/19, and C.P. 29/320. Co. 281, therefore, was the only variety recommended as a wind-rowing cane.

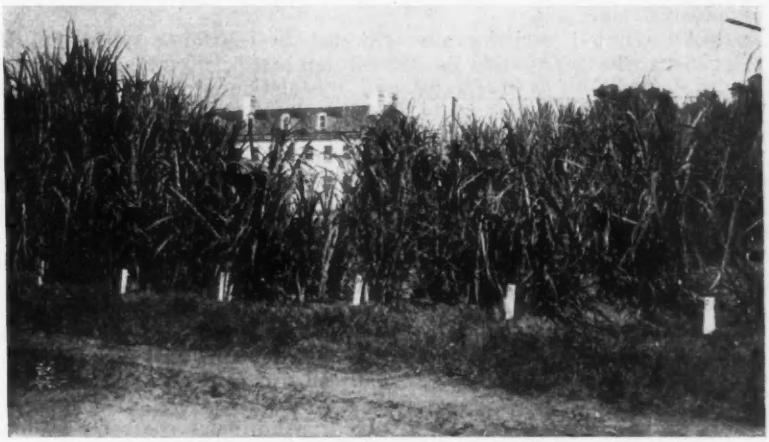

Fig. 57.—Mosaic strain experiment plot at Houma Experiment Station.

(2) The injury to erect cane makes its appearance in the spindle and the tops of the leaves, and moves downwards as the freezing temperatures become more severe, killing the leaves, terminal buds, eyes and stalk. The symptoms associated with the spindle, terminal buds, and leaves, are aids in determining the amount of injury to cane showing less degrees of damage. As the injury becomes more severe, the increase in leaf injury, the splitting of internodes, and the amount of internal and external discoloration of the stalks are aids in determining the degree of injury. The lower eyes are usually the last to be killed, and the number of eyes killed is a fairly accurate measure of the degree of injury so long as there are any eyes remaining sound. During 1932-33 to 1936-37, Co. 281 and Co. 290, showing varying degrees of injury as measured by the number of eyes killed, were wind-rowed each season.

Results indicate that so long as any eyes remain sound the cane will keep in the wind-row from two to three weeks without development of abnormal changes. The results with cane in which all eyes were killed have varied somewhat, but on the whole such cane showed considerable abnormal changes in two weeks.

Cane breeding has apparently not advanced to such a stage, however, that parents can be selected to give frost resistant progeny.

Diseases in Louisiana.

Mosaic.—As is well known, the Louisiana sugar industry suffered disastrously some 12-15 years ago as a result of the depredations of mosaic disease, and this disease is still of first-rate importance. In recent years the problem of developing resistant varieties has been intensified by the discovery of the fact that there exist in Louisiana several strains of the virus which causes moisaic (six strains and three sub-strains are known). (*See* Fig. 58.) These strains may produce identical symptoms, and hence the presence of more than one strain could not be determined by inspection, but they attack cane varieties differentially. Thus a variety which has appeared to be resistant to mosaic may suddenly appear susceptible, due to the introduction of another strain.

All selected varieties are subjected to resistance trials and in Louisiana the inoculation is carried out artificially and not under natural conditions as in Queensland. Inoculation is carried out in very young cane and it appeared to the writer that this practice was somewhat unsound since that period in the natural growth of cane did not coincide with the period when insects which spread the disease are most numerous. As resistance to mosaic increases with age, it would seem that the inoculation should be carried out at a stage in growth corresponding to the period of greatest spread by the insect vectors.

Red Rot—In another place in this report reference is made to the fact that there is a long period (three months) elapsing before germination when cane is planted in the autumn in Louisiana. It is during this long period of dormancy under cool conditions that red rot takes its toll; setts become infected through the cut ends and a large proportion of the eyes may be killed. As a result all promising varieties must be subjected to red rot resistance tests and a reasonably high degree of resistance to this disease is essential. Additional control is being obtained by summer planting, whereby the setts germinate quickly and so escape much of the red rot attack, and the young crop is then "ratooned" over the winter (see page 173). Red rot in Queensland is primarily a disease of over-ripe cane, but the shortness of the growing season precludes the development of over-maturity in Louisiana.

Chlorotic Streak—Chlorotic streak was found in Louisiana following the discovery of a suspected unquarantined introduction of P.O.J. 2878 from Puerto Rico by a plantation owner. The disease is now spreading rapidly and, in particular, was observed to be attacking a promising new seedling C.P. 29/320.

Method of Cane Payment—Louisiana.

Briefly the method is as follows:—Owing to the manner of delivery of cane to the factory, where it is dumped in large heaps in the mill yard, and later picked up and put into the carrier, analysis of the

individual farmer's cane during milling is not possible. Therefore sample sticks are taken from the waggons as cane is delivered and these are crushed in small, three-roller mills for juice analysis. To convert small mill analysis to crusher juice analysis an arbitrary factor is used: 5 per cent. is deducted from the brix, and 10 per cent. from the polarization. This is the analysis on which payment is then made by the mill. Payment is based on sucrose determination only, no significance being attached, for payment purposes, to the juice purity. A given figure of sucrose is called 100 per cent. standard cane, and this 100 per cent. increases by one unit for each 0·1 per cent. rise in the sucrose, and decreases by two units for each 0·1 per cent. drop in sucrose.

The data given in Table I. explain the method:—

TABLE I.—Conversion Factors to be Used in Determining Standard Cane from Actual Cane with Sucrose in Normal Juice from 9·5 Per Cent. to 18 Per Cent.

Western Contract: *Par* 11·5–12·5.

Per Cent. Sucrose in Normal Juice.	Per Cent. Standard Cane.
9·5	60
9·6	62
9·8	66
10·0	70
10·4	78
11·5	100
12·5	100
12·9	104
14·2	117
14·6	121
16·5	140
17·0	145
18·0	155

Eastern Contract: *Par* 11·5–12.

Per Cent. Sucrose in Normal Juice.	Per Cent. Standard Cane.
9·5	60
9·6	62
9·8	66
10·0	70
10·4	78
11·5	100
12·5	102·5
12·9	106·5
14·2	119·5
14·6	123·5
16·5	142·5
17·0	147·5
18·0	157·5

The Eastern Contract varies from the Western only in that Par is 11·5-12; there is the same drop of two units standard cane for each 0·1 per cent. decrease in sucrose below 11·5, but from 12 to 12·5 sucrose the increase in standard cane is 0·5 for each 0·1 sucrose. Above 12·5 sucrose the increase is one unit standard cane for each 0·1 sucrose.

This conversion factor is then utilized for cane payment. The grower is paid approximately 1 dollar per ton of standard cane for

each 1 cent per lb. that sugar is bringing on the market. For example, if sugar price is 3·50 cents per lb., the grower obtains 3.50 dollars per ton of cane. But here again a factor is used on a sliding scale to obtain the actual price paid. Below 3·50 cents per lb. for sugar the factor becomes increasingly less than 1·00, and above 3·50 cents per lb. the factor is increasingly above 1·00. A few examples from the table will make this clear.

Average Price of Raw Sugar	Price Factor.	Price of Standard Sugar-cane.
2·75 cents	·9100	2·503 dollars
2·85	·9220	2·628
2·95	·9340	2·755
3·05	·9460	2·885
3·15	·9580	3·018
3·25	·9700	3·153
3·35	·9820	3·290
3·45	·9940	3·429
3·50	1·0000	3·500
3·55	1·0060	3·571
3·65	1·0180	3·716
3·75	1·0300	3·863

Added to this price is approximately 1 dollar per ton of cane, paid to the grower by the Government under the Agricultural Adjustment Act.

Taking an example from these tables of, say, 14·6 per cent. sucrose, we find that this is equivalent to 121 per cent. standard cane. With sugar at 3 cents per lb.—which is close to the present ruling rate—standard cane is worth 2·82 dollars per ton. Calculated to 121 per cent. standard cane the price paid per ton of cane is 3·41 dollars. One dollar per ton subsidy makes it 4·41 dollars or approximately (at 3·70 dollars per £1 Australian) £1 3s. 10d. per short ton or £1 6s. 8d. per long ton.

Visit to Alcohol Distillery at New Orleans, Louisiana.

The trip through the distillery was a very rushed one and the following brief notes were all that could be picked up on the way. Molasses is brought in from many parts of the world—including places as far away as Java. A tax is levied on foreign molasses (not including Puerto Rico and Hawaii) to the extent of 3 cents per 100 lb. of sugar in the molasses.

Invert analysis is carried out on all molasses coming in, and the figure is known as "invert sugar input." Recovery is always calculated on lb. of invert sugar used per United States gallon of 95 per cent. alcohol; 15·3 lb. of invert sugar are required to give 1 United States gallon of 95 per cent. alcohol. The molasses should contain at least 0·1 per cent. nitrogen for best fermentation; if this amount is not present it should be added as ammonium sulphate. The over-all recovery is 87 per cent. of 95 per cent. alcohol. The true recovery is probably higher—on true sugar content—since certain non-sugars reduce copper in the initial analysis of the molasses, but are not convertible to alcohol; 10 per cent. of the apparent sugars are lost as non-fermentable.

The capacity of the plant is 10,000,000 United States gallons per year. The plant uses 50,000 United States gallons of molasses daily, and produces 20,000 United States wine gallons of alcohol daily. Natural gas is used in the furnaces to the extent of 1,000,000 cubic feet per day, with a calorific value of 1,000 B.T.U.'s per cubic foot.

Molasses costs 2¼ cents to 6 cents per United States gallon, delivered at the plant. The best mixture for fermentation is 60 per cent. high test molasses and 40 per cent. blackstrap.

The beer still plates are 6 ft. in diameter and, with 6-8 per cent. alcohol in the wash, less than ·005 per cent. of alcohol is left in the residue.

The 95 per cent. spirit is suitable for vinegar making, methylating and anti-freeze mixtures; 40 per cent. of the production goes for the latter purpose. The 95 per cent. alcohol is treated with benzol for the further rectification by the azeotropic process. The alcohol comes from the still at 99·95 per cent.

One pound of alcohol produces at the same time 1 lb. of dry ice of 100 per cent. purity. A two stage compressor is used at 1,000 lb. per square inch. The pressure converts the CO_2 to liquid CO_2, it is cooled to —50 deg. Fahr. at 1,000 lb. pressure, and expands through the nozzle from 1,000 to 60 lb. One lb. is converted to snow and 1 lb. to gas —used for cooling the compressed CO_2 above. The snow is pressed into blocks at 22 lb. pressure. The blocks keep in insulated cardboard containers for 4-5 days. Temperature of the block is —110 deg. Fahr.

It was stated that the overall cost of production of azeotropic process alcohol was 20 cents per United States gallon with the cost of raw material, as stated above, varying between 2¼ and 6 cents per United States gallon.

Mosaic in S.J. 2.

The field officers of the Bureau report an increasing amount of mosaic disease in the variety S.J. 2 in the Mackay and Lower Burdekin districts. Mosaic is, as a rule, one of the easiest of diseases to recognise and control, and farmers in these districts are urged to give the situation the requisite care and attention. S.J. 2 is a valuable high sugar-cane under suitable conditions, but it cannot continue to be an approved variety if it is allowed to become seriously infected with mosaic.

Mosaic disease produces an easily recognisable, yellowish mottling of the cane leaves, but any farmer not familiar with the symptoms should consult the nearest field officer of the Bureau. Control of this disease may be brought about by attention to the following points:—

1. Inspect cane before cutting for plants and reject any mosaic-diseased stools;
2. Dig out any diseased plants which may be found from time to time;
3. Keep fields *and headlands* free from weeds;
4. Plant in autumn in preference to spring, as autumn-planted cane is more resistant;
5. Do not plant corn or sorghum near cane.

Mosaic disease attacks a number of wild and cultivated grasses in addition to cane, and will spread into cane from diseased grasses in fields and on headlands. The disease is spread by an insect, the corn aphid, which does not breed in cane but breeds up profusely in corn and other members of the grass family.

A.F.B.

Approved Varieties.

The following are the varieties approved for planting in the various mill areas (as set out hereunder) during the calendar year 1939. It should be noted that the planting of any other variety, whether for milling, use as fodder, or any other purpose, is prohibited. Any person planting a variety not approved is liable to a penalty not exceeding one hundred pounds.

Mossman Mill Area.

Badila, Clark's Seedling, S.J. 4, P.O.J. 2878, Pompey, Korpi, H.Q. 409, D. 1135, Oramboo, and Q. 2.

Hambledon Mill Area.

S.J. 4, Badila, Pompey, D. 1135, H.Q. 409, Clark's Seedling, Q 2, H.Q. 458, and Q 813.

Mulgrave Mill Area.

Badila, H.Q. 409, D. 1135, B. 147, Q. 2, Korpi, Oramboo, P.O.J. 2725, P.O.J. 2878.

Babinda Mill Area.

Badila, Clark's Seedling, B. 147, Q. 2, D. 1135, H.Q. 409, H.Q. 458, Q. 813, Korpi, and Oramboo.

Goondi Mill Area.

Badila, Pompey, H.Q. 409, Q. 2, S.J. 4, and Clark's Seedling.

South Johnstone Mill Area.

Badila, Pompey, H.Q. 409, Q. 2, S.J. 4, and Clark's Seedling.

Mourilyan Mill Area.

Badila, Pompey, H.Q. 409, Q. 2, S.J. 4, and Clark's Seedling.

Tully Mill Area.

Badila, Clark's Seedling, H.Q. 409, Q. 813, and Q. 2.

Macnade Mill Area.

Badila, H.Q. 409, Q. 813, Hector, Juno, Brutus, Vulcan, Q. 2, and P.O.J. 2878.

Victoria Mill Area.

Badila, H.Q. 409, Q. 813, Korpi, Q. 2, Juno, Brutus, Vulcan, P.O.J. 2878.

Invicta Mill Area.

Area lying north of Townsville.

Badila, Nanemo, H.Q. 409, S.J. 2, Q. 813, Q. 2, Oramboo, Korpi, P.O.J. 2725. The variety Clark's Seedling may only be planted in the section south of Cattle Creek.

Area lying south of Townsville.

E.K. 28, Badila, Clark's Seedling, B. 208, Korpi, P.O.J. 2714, P.O.J. 2725, S.J. 2, S.J. 4, and S.J. 7.

Pioneer Mill Area.

Badila, E.K. 28, Clark's Seedling, Korpi, S.J. 2, S.J. 4, S.J. 7, and P.O.J. 2725.

Kalamia Mill Area.

Badila, E.K. 28, Clark's Seedling, Korpi, S.J. 2, S.J. 4, S.J. 7, and P.O.J. 2725.

Inkerman Mill Area.

Badila, E.K. 28, Clark's Seedling, Korpi, S.J. 2, S.J. 4, S.J. 7, and P.O.J. 2725.

Proserpine Mill Area.

1900 Seedling, E.K. 28, Badila, Clark's Seedling, Q. 813, S.J. 2, Korpi, Co. 290, and P.O.J. 2725.

Farleigh Mill Area.

1900 Seedling, Badila, Co. 290, E.K. 28, S.J. 2, Clark's Seedling, Q. 813, Oramboo, Korpi, and P.O.J. 2725. P.O.J. 2714 and P.O.J. 2878 may only be planted in land situated within the parishes of Ossa, St. Helens, Lacy, and Bloomsbury.

Racecourse Mill Area.

1900 Seedling, Badila, Co. 290, E.K. 28, S.J. 2, Clark's Seedling, Q. 813, Oramboo, and P.O.J. 2725. P.O.J. 2714 and P.O.J. 2878 may only be planted in land situated within the parishes of Ossa, St. Helens, and Pelion.

Pleystowe Mill Area.

1900 Seedling, E.K. 28, Q. 813, Clark's Seedling, Badila, S.J. 2, Co. 290, Oramboo, and P.O.J. 2725. P.O.J. 2714 and P.O.J. 2878 may only be planted in land in the parishes of Ossa, St. Helens, and Lacy, and those parts of the parishes of Hamilton and Pelion known as Owens' Creek and on farms loading cane at sidings between and including both Langdon and Kungurri.

Marian Mill Area.

1900 Seedling, E.K. 28, Q. 813, Clark's Seedling, Badila, S.J. 2, Co. 290, Oramboo, and P.O.J. 2725. P.O.J. 2714 and P.O.J. 2878 may only be planted in land situated within the parishes of Ossa, St. Helens, and Lacy, and those parts of the parishes of Hamilton and Pelion known as Owens' Creek, Silent Grove, and Mount Charlton, and on those farms loading cane on sidings between and including both Langdon and Kungurri.

Cattle Creek Mill Area.

1900 Seedling, E.K. 28, Badila, S.J. 2, Clark's Seedling, Q. 813, Oramboo, P.O.J. 2725, and Co. 290.

North Eton Mill Area.

1900 Seedling, E.K. 28, Badila, S.J. 2, Clark's Seedling, Q. 813, Oramboo, P.O.J. 2725, and Co. 290.

Plane Creek Mill Area.

1900 Seedling, E.K. 28, P.O.J. 2878, Badila, Clark's Seedling, S.J. 2, P.O.J. 2714, P.O.J. 2725, Q. 813, Co. 290, and Oramboo.

Bingera Mill Area.

P.O.J. 2878. Co. 290, P.O.J. 213, Korpi, Mahona, P.O.J. 234, P.O.J. 2725, Oramboo, and Q. 813.

Fairymead Mill Area.

Co. 290, P.O.J. 2878, P.O.J. 213, P.O.J. 234, P.O.J. 2725, Oramboo, Korpi, and Q. 813.

Millaquin Mill Area.

Co. 290, P.O.J. 2878, P.O.J. 213, P.O.J. 234, P.O.J. 2725, Oramboo, Korpi, and Q. 813.

Qunaba Mill Area.

Co. 290, P.O.J. 2878, P.O.J. 213, P.O.J. 234, P.O.J. 2725, Oramboo, Korpi, and Q. 813.

Gin Gin Mill Area.

P.O.J. 2878, Co. 290, P.O.J. 213, Korpi, Mahona, P.O.J. 234, P.O.J. 2725, Oramboo, and Q. 813.

Isis Mill Area.

Isis District.

P.O.J. 2878, P.O.J. 213, P.O.J. 2725, P.O.J. 234, P.O.J., 2875, Co. 290, and Q. 813.

Pialba District.

Q. 813, H.Q. 285, Korpi, Co. 290, P.O.J. 213, P.O.J. 234, and P.O.J. 2878.

Maryborough Mill Area.

Pialba District.

Q. 813, H.Q. 285, Korpi, Co. 290, P.O.J. 213, P.O.J. 234, and P.O.J. 2878.

Maryborough District.

Q. 813, H.Q. 285, Oramboo, Korpi, Co. 290, Mahona, P.O.J. 213, and P.O.J. 234.

Mount Bauple Mill Area.

Q. 813, Co. 290, H.Q. 285, P.O.J. 213, P.O.J. 234, P.O.J. 2725, P.O.J. 2878, and Oramboo.

Moreton Mill Area.

Q. 813, Oramboo, H.Q. 285, Korpi, Co. 290, P.O.J. 213, and P.O.J. 2878.

Eagleby Mill Area.

Q. 813, H.Q. 285, Oramboo, Korpi, Co. 290, P.O.J. 213, and P.O.J. 234.

Rocky Point Mill Area.

Q. 813, H.Q. 285, Oramboo, Korpi, Co. 290, P.O.J. 213, and P.O.J. 234.

H. W. KERR,
Director, Bureau of Sugar Experiment Stations.

Prosecutions for Non-compliance with Orders Issued for the Destruction of Diseased Cane.

Owing to the susceptibility of P.O.J. 2878 (particularly) to downy mildew and Fiji diseases, it became necessary last season to initiate a rigorous campaign for the cleaning up of danger spots. In the course of this campaign Bureau officers were forced to issue some dozens of "eradication orders," the majority of which required the early harvesting and ploughing out of particular fields of cane. Naturally, there is no pleasure in either the serving or the receipt of such orders, but, for the most part, they were received in the sincere spirit in which they were issued and growers co-operated loyally in helping to improve the situation. Unfortunately, there were two instances (one at Mackay and one at Bundaberg) in which the recipients of the orders persistently failed to comply with the requirements thereof, and it was necessary to institute court proceedings against the offenders. As these were the first offences in each of these districts a heavy penalty was not requested and each person was fined a sum of three pounds.

Disease eradication orders are only issued in cases of urgent necessity, and it is hoped that there will be no need for further prosecutions.

A.F.B.

Cane Disease Infested Areas.

The amending clauses of "*The Sugar Experiment Stations Acts, 1900 to 1938*," provide for the declaration of cane disease infested areas, and the subsequent creation of Cane Disease Control Boards, on lines similar to those which have obtained for many years in respect of cane pest infested areas and Cane Pests Boards.

In view of the serious potentialities of gumming disease in the Mulgrave district, downy mildew at Mackay, and Fiji and downy mildew diseases in Southern Queensland, the following areas have been declared to be cane disease infested:—

1. Mulgrave (comprising the Mulgrave Mill area).
2. Mackay (comprising the Farleigh, Racecourse, Pleystowe, Marian, Cattle Creek, and North Eton Mill areas).
3. Bundaberg (comprising the Bingera, Fairymead—excepting that portion lying within the Parish of Gregory—Gin Gin, Millaquin, and Qunaba Mill areas).
4. Isis (comprising that portion of the Isis Mill area lying within the Parishes of Childers, Gregory, and Booyal).
5. Maryborough (comprising the Bauple and Maryborough Mill areas and that portion of the Isis Mill area lying within the Parishes of Vernon and Urangan).
6. Moreton (comprising that portion of the Moreton Mill area lying north of the Brisbane River).

Steps have now been taken to constitute Disease Control Boards for the above areas, and it is anticipated that the operation of these Boards will bring about a distinct improvement in the disease situation.

A.F.B.

Red Stripe (Top Rot) Disease in 1939.

Reports received during the current season indicate that death of cane due to top rot is rather more prevalent this autumn than usual. Such a situation was expected to eventuate, following the generally dry conditions of last spring. Top rot is largely a seasonal disease, and is closely related to the vigour of the crop. During a dry spring and early summer the crops generally are severely checked in growth, and this condition renders them particularly susceptible to top rot with the onset of the rainy season and the commencement of rapid growth.

Generally speaking, the older and more advanced the crop the more resistant it is to top rot, and for that reason autumn-planted cane is much less liable to the disease than spring-planted cane. That is not to say that autumn-planted cane will always escape the disease; if the spring is very dry, or if the moisture-holding capacity of the soil is low, or if the cane is overcrowded, then considerable death may occur in autumn-planted cane. In general, however, the autumn-planted crops escape without very much damage.

There is, of course, a great difference in the resistance of different varieties, and S.J. 4, Badila, and P.O.J. 2878, for example, are much more susceptible than Q. 2, Q. 10, Clark's Seedling, and P.O.J. 2725. Q. 2 is, in fact, highly resistant, and damage in that variety would be rare; odd stalks will be killed, but dead stalks would be numerous only if the variety were grown alongside a badly-diseased field of a susceptible variety.

Overcrowding of stalks also increases susceptibility to top rot, and consequently it is desirable to avoid over-heavy fertilization, particularly late in the season.

Top rot is a very striking disease, and always appears to be causing more damage than is actually the case. The reason for this is that there is always a compensating increased growth of the remaining stalks; in fact, if the death takes place early, say, in January, there is really very little loss, while if death takes place as late as the end of March there is somewhere about 50 per cent. compensation.

A.F.B.

Damage to Cane Soils by Arsenic.

The use of white arsenic as a means of grub control has been employed in the Giru area for a number of years. While our entomologists have agreed that in certain circumstances a partial control is possible, the practice has been discouraged as being costly and often disappointing. At the same time the possibilities of damage to the soil due to arsenic accumulations have been stressed.

There was brought to our notice recently a case of a farmer who had consistently employed arsenic for this purpose in a field in which the cane now grows only about 12 in. tall and then dies off. Analysis of a sample of soil from the field showed the presence of arsenic at the excessive rate of 600 parts per million of soil. As arsenic is held tenaciously by the soil, in a manner similar to phosphate, it will probably be many years before the excess arsenic has been leached away or rendered inactive.

H. W. K.

Effects of Downy Mildew at Mackay.

Some time ago the Bureau announced the yield results for three of the seedlings raised at the Mackay Station. Of these a new variety known locally at "C. 83" was of outstanding merit in respect of tonnage yield per acre. For three crops (plant, first and second ratoon), it yielded 17·3 tons of C.C.S. per acre, as compared with 12·3 tons of C.C.S. for the standard, Q. 813.

The new cane is a seedling of P.O.J. 2878, and unfortunately carries the susceptibility to downy mildew disease exhibited by its parent. It is, therefore, not possible to have this cane released for general distribution, solely for the reason that the presence of this disease in Mackay would render it a ready victim in virtually all areas.

Growers will therefore appreciate that the ill effects of cane diseases lie not only in their influence on the present standard canes, but also in the restrictions they place automatically on new canes which do not happen to be resistant. Again, it is evident that diseases are costly from whichever aspect they are viewed, and all farmers should exert a strenuous and concentrated effort to eradicate them. This seedling will be maintained in isolation but will not be released for planting until such time as the downy mildew situation is satisfactorily cleaned up.

H. W. K.

The Variety Q. 20 in the Mackay Area.

At the present time a new variety which was produced at the Mackay Station is undergoing yield trials on several farms in the Mackay area. It is a seedling of Badila. We are now in possession of a considerable amount of information concerning the cane, which is given the serial number Q. 20; the main features are:—

1. Moderately good yields in comparison with the standard canes of the area: appears to be superior in ratoon yield.
2. Good ratooning cane, at least when cut at favourable times.
3. Arrows rarely, and then only late and sparsely.
4. Resistant to downy mildew disease—a very important point.
5. Somewhat inclined to trash binding, but does not become badly trash bound.
6. Rather sparse foliage, calling for close planting to give better coverage.
7. Gives extraordinarily sweet and pure juices during mid-season.

The lastnamed characteristic is particularly interesting. In several juice tests it has shown purities of 95, and it is usually about 2 units better than the standard of comparison in this regard. Mill tests of 18 C.C.S. and better have been recorded.

It is not suggested that this is a cane of outstanding merit, but if observations on the existing trial plots continue to confirm present opinions, the variety will be released for general distribution in the coming spring.

H. W. K.

Cane and Tractor School at the Queensland Agricultural High School and College.

By C. G. Story.*

Successful agriculture to-day depends to a large extent on the application of science to the many problems which confront the primary producer, and many of the old theories have been replaced with more modern and scientific methods which have increased production per acre, while decreasing production costs. It is possible only by studying all aspects of each particular branch of agriculture that this position may be attained; this is particularly so in the case of the sugar industry, which in Queensland embraces a large and varied area stretching from Mossman in the north to Beenleigh in the south.

This year—due to collaboration between the Principal of the Queensland Agricultural High School and College, the Bureau of Sugar Experiment Stations, the Queensland Cane Growers' Council, the Australian Sugar Producers' Association, and Tractor Firms—the first combined Cane and Tractor School was held at the College from the 24th January to the 3rd February, inclusive.

Every sugar district was represented at the school, where there was an enrolment of eighty students, but to Mackay must be given the credit of being the best represented area, as nearly half of the students came from this area, with Ingham the second on the list.

A comprehensive course embracing work of both theoretical and practical nature was outlined in a syllabus covering Cane Soils and Agriculture, Cane Diseases and Pests, Tractors and Animal Husbandry. The mornings were devoted to lectures, and the afternoons to practical work. During the series of lectures an epidiascope was used to illustrate any points, which the lecturer particularly wished to stress.

For the information of growers a brief summary of the lectures and practical work involved under these subjects will be outlined.

Cane Soils and Agriculture.

This course comprised a series of six lectures embodying—

Soils and Plant Nutrition.—The evolution of soil from the parent rock was traced and specimens of rocks which play a part in the formation of Queensland cane soils were exhibited during the lecture. Plant nutrition to-day is an advanced science, and its essentials were outlined to show the materials necessary for the growth of the cane plant, and the manner in which the soil is linked with this process of crop production.

Soil Moisture.—This subject was dealt with under a number of headings, the principal being—

(*a*) Availability of moisture in the soil;

(*b*) The nature of the moisture film;

(*c*) Field moisture-holding capacity of Queensland cane soils;

(*d*) Amount of moisture available for use by plants in the different types of Queensland cane soils.

* Mr. Story attended the school as a student and his comments are therefore made from the viewpoint of a student member of the school.

Cane Land Cultivation.—The general methods, and reasons for cultivation, with the pros and cons of cultivation, were discussed; special emphasis was laid upon those incorrect practices which pulverise and tend to destroy the general structure of the soil.

Fig. 58.—General view of tractors in action.

(*Photograph: Courier-Mail.*)

Green Manuring and Trash Cultivation.—This is a big subject which could not be fully dealt with in the period allowed, but some interesting points were brought forward and discussed; among these were (*a*) the effect on the humus content of the soil of the ploughing-under of green manure and trash; (*b*) the different varieties of green manure for both summer and winter crops, and the general usefulness of a green manure in addition to being a cheap provider of nitrogen; (*c*) the early working of the land in which trash has been ploughed under was condemned, as the trash-rotting bacteria are disturbed, and other harmful effects which may arise from this practice were also stressed; (*d*) in cases where a green manure crop is not grown and ploughed under with the trash, it is desirable to make an application of superphosphate and sulphate of ammonia to help the bacteria in their work of decomposing a large body of trash; (*e*) the increased result experienced due to trash conservation over a number of years at the Bundaberg Experiment Station in the Trash Trial plots.

Irrigation.—The lecture covered the following points:—Irrigation areas, the types of irrigation in use, types of wells, general classification of suitability of water, various types of spray systems, permeability of soil and amounts of salts held in surface of soil, effect of harmful ingredients of water on soil, and their prevention.

Fig. 59.—Students at tractors, with lecturers in foreground.
(*Photograph: Courier-Mail.*)

Fig. 60.—Demonstration lecture on tractor engine.
(*Photograph: Courier-Mail.*)

Fertilizers and Their Use.—Fertilizer practice in cane areas is a subject which should receive more study from the farmer than it does, and during this lecture, when types of fertilizer, fertilizer trials and results, and economic fertilization were discussed, it was shown that by not giving a little forethought to this subject a farmer is liable to lose money by wrong fertilizing practices.

Practical Work.—This was carried out in the laboratory, and covered the methods employed in a soil laboratory for determining—(1) the moisture-holding capacity of soils, (2) the humus in a soil, (3) pH test for acidity as employed in the field, and (4) available phosphate content.

In addition to this practical work, supplementary lectures were given on these tests, while they were being carried out.

Cane Diseases and Pests.

Queensland is unfortunate enough to have most of the major cane diseases, and a series of lectures on this subject covered factors liable to produce disease, types of diseases, the history and distribution, symptoms, transmission and control of the major cane diseases affecting the different areas of Queensland; there was also a general lecture on the major cane pests of this State, while cane breeding was also included in this series of lectures.

There are two methods of obtaining varieties for Queensland cane areas. First is the importation of outstanding varieties from overseas, which may be of use in this country from a crop or breeding standpoint; in this case they are placed in isolation in a special type of quarantine glasshouse before being forwarded to the cane areas for further propagation. The lecturer explained this aspect very fully, also the second method, namely, the breeding and raising of seedlings in Queensland from the time of pollination until the cane seedlings are finally distributed as improved varieties among the farmers. This work is extended over a period of years before the breeder knows whether the batch of seedlings raised in that year will produce anything outstanding, both as regards a general purpose and disease-resisting variety of cane.

The practical work on diseases in the laboratory was very interesting from the students' point of view, as organisms causing diseases in cane were shown under microscopes to the students; the method of culturing and isolating causal organisms was also demonstrated. Fresh specimens of cane diseases, which had been kept in cold storage at the College, were exhibited during the practical period with a further explanation of these diseases.

Another practical demonstration which will be of use to farmers at the time of planting green manure crops, was the method of inoculation of legume seed with a suitable culture of nitrogen-forming bacteria.

Tractors.

To-day, modern farming is becoming mechanised, tractors replacing horses for the heavier work to a very large extent. This section of the school was ably handled by a number of lecturers, and the subjects covered included:—

Four-cycle Engines and Diesel Engines.—An outline of the principle and method of operation of the Four-stroke Engine, explanation of Diesel Engines, and a comparison between Gas and Diesel Engines was given. The following subjects were very fully discussed both from the point of view of their design and method of operation as parts of a tractor:—

Carburettors and Magnetos.

Clutches and Differentials.

Transmission and Steering of Crawler Tractors.

Gear Boxes and Drives.

Cooling Systems.

Three other lectures in this series dealt with:—

(i.) *Tractor Lubrication.*—A supplementary film on this subject supported the lecturer's remarks, and also showed the operation of a Diesel Engine.

(ii.) *Rubber Tyred Equipment for Farm Machinery.*—Steel wheels were compared with rubber tyred machinery, points raised in favour of the latter being saving of fuel, increase of power, and saving on the tractor owing to less vibration. Hints on the correct inflation of rubber tyres, treatment of a new tractor tyre when it arrives at the farm, the method of filling the tyres with water, together with a film on rubber tyred machinery completed the lecture on this particular subject.

(iii.) *Tractor Costing.*—Costs play a large part in the operation of a tractor, and it was appropriate that the final lecture for the tractor section was given on this subject, which included the method of working and the total cost per working day of the tractor.

The afternoon periods of the school were spent on practical work with tractors, both in the shed and in the field. For demonstration purposes the students were allotted to groups, and each group spent one afternoon with a different make of tractor. One section of the practical work which was followed with great interest was the taking up and adjustment of bearings, the inspection of a stripped tractor and parts, instruction being given on the different parts of the stripped tractor.

Twelve tractors of various makes and horse power were generously supplied by tractor firms, and the mechanics in charge explained the details of their mechanism, and methods of operation.

The tractors were tested under working conditions by the students on both light and heavy soils, both wet and dry conditions being experienced. The testing ground became a veritable hive of industry when the twelve tractors were working.

Animal Husbandry.

Even though farming to-day is becoming mechanised, horses still play a large part in the working of a cane farm. Lectures in animal nutrition were devoted to—(1) A description of the general digestive organs and their functions; (2) economical and efficient feeding of farm horses.

Horses were killed for a practical demonstration of the organs of a horse and their general function, while lectures were also given on diseases and common ailments affecting the horse. Pig raising as a profitable sideline which might be undertaken by cane farmers in suitable localities was illustrated by a lantern lecture.

General.

Educational films were shown at night, and embraced both mechanical and general subjects, while moving picture entertainment was also provided for the recreation of students, who, in their turn, provided entertainment for the College Staff at a Farewell Evening in the form of a concert with supper to follow.

The Queensland Agricultural High School and College, which may lay claim to being the best in Australia, is situated in the fertile Lockyer Valley, and in order to acquaint the students with this area a tour of portion of the Lockyer district was made on the Sunday afternoon.

As a mark of appreciation to Professor Murray and his Staff for the capable manner in which they had undertaken the responsibility for the welfare of the students while at College, a sum of money was subscribed and presented to Professor Murray to enable the purchase of a piece of scientific equipment which will be inscribed so as to commemorate the success of the school.

Although in the nature of an experiment, this first school was very successful, and the students, who are the cane farmers of to-morrow, benefited considerably by their attendance both from the theoretical and practical side; it is hoped that the knowledge gained, which enlightened them on many subjects, will be suitably applied to improve the agricultural technique of cane farming, and pave the way for a better understanding of many of the agricultural problems which confront them in everyday life.

"The Sugar Experiment Stations Acts, 1900 to 1938."

Regulations for the implementing of the provisions of the amended Sugar Experiment Stations Act have now been gazetted. The complete Act and Regulations are being printed in convenient book form and copies may be obtained by interested persons on application to the Director, Bureau of Sugar Experiment Stations, Brisbane. As the legal phraseology employed in the wording of such Acts and Regulations is somewhat difficult of interpretation, a concise statement has been posted to every registered canegrower, but any grower who has failed to receive same is asked to communicate with the Bureau and an additional copy will be forwarded immediately upon request.

A.F.B.

David Whyte, Government Printer, Brisbane.